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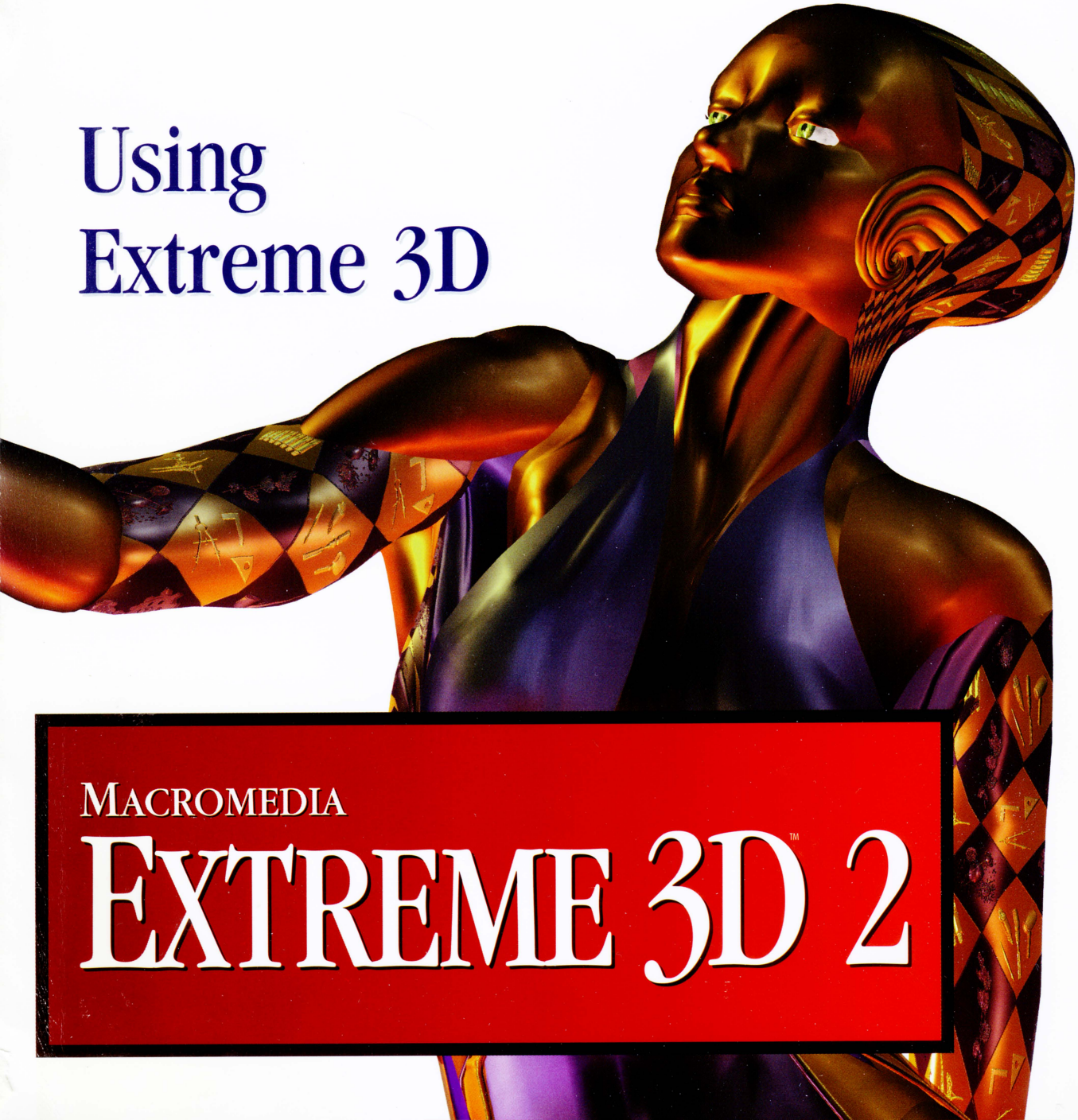
Using Extreme 3D



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Introduction
Getting ready

Welcome to Macromedia's Extreme 3D, the best tool for modeling, animating, and rendering three-dimensional objects.

This introduction contains:

- A list of what's included in your Extreme 3D package
- Information about system requirements for Extreme 3D
- Instructions for installing and starting Extreme 3D
- Suggestions for using the manuals, online training movies, and Help system
- A description of the new features in this version of Extreme 3D

What's included with Extreme 3D

Your Extreme 3D package includes the following items:

- A CD that contains:
  - The Extreme 3D installer and application
  - The *Learning Viewer* and *Learning Extreme 3D* training movies, Materials and Lighting Labs, example files, and informational text files
  - The Extreme 3D Help application
- The *Using Extreme 3D* printed manual that contains:
  - The *Quick Start* tutorial that walks you through the production flow of creating a model, animating it, creating lighting effects, and applying materials
  - A complete guide to using Extreme 3D

System requirements

You can use Extreme 3D with either a Macintosh computer or a computer running Windows. Before you install Extreme 3D and begin using the application, you need the following equipment:

Macintosh systems

Component	Requirement
Microprocessor	Power Macintosh.
RAM	16 MB of free RAM are required; 24 MB or more are recommended.
Hard Disk	20 MB of free hard disk space is required for installation.
Video	8-bit graphics card minimum. 24-bit graphics card recommended. (32K or more colors provides better visual results for final rendering.)
Operating System	System software version 7.1 or later with QuickTime extension. QuickDraw 3D recommended.

Windows systems

Component	Requirement
Microprocessor	486 DX or SX with Floating Point Coprocessor or greater.
RAM	16 MB of RAM are required; 24 MB or more are recommended.
Hard Disk	20 MB of free hard disk space is required for installation.
Video	8-bit graphics card minimum. 24-bit graphics card recommended. (32K or more colors provides better visual results for final rendering.)
Operating System	Windows 95, Windows NT 4.0, or Windows 3.51 (or later). Direct3D recommended.

Installing and starting Extreme 3D

This section describes how to install Extreme 3D on your hard disk and start the application. Before you begin, make sure your computer meets the system requirements described on page 3.

Tip: Before getting started with Extreme 3D, you might want to look at the Learning Extreme 3D training movies and Materials and Lighting labs with the Learning Viewer, located on the application CD.

Note: If you have another version of Extreme 3D installed on your machine, install this version in a new location. Update your lights and materials catalog by moving your .LIT, .TEX, and .MAT files to the Scripts folder in this new location.

Installing and starting Extreme 3D on a Macintosh

1. **Make sure the application CD is in your CD drive.**
2. **Locate the installer on the application CD.**
3. **Click the Extreme 3D installation icon and choose Install.**
4. **Follow the instructions that appear onscreen.**
   The installation program prompts you to enter required information.
5. **When Extreme 3D is installed, you can launch Extreme 3D by double-clicking the Extreme 3D icon.**
   You can find the icon in the folder you specified during installation. Extreme 3D starts.

Installing and starting Extreme 3D in Windows

1. **Make sure you're running Windows and the applicaiton CD is in your CD drive.**
2. **Using the Program Manager (in Windows NT 3.5.1) or the Explorer (in Windows 4.0 NT or Windows 95), locate the Extreme 3D installer.**
3. **Double-click Setup.exe.**
4. **Follow the instructions that appear onscreen.**
   The installation program prompts you to enter required information.
5. **When Extreme 3D is installed, you can launch Extreme 3D by clicking on the Extreme 3D executable.**
   You can find the executable in the folder you specified during installation. Extreme 3D starts.

Note: Extreme 3D puts information in the registry when it installs. Use UnInstall for removing Extreme 3D.

Resources for learning Extreme 3D

Both online and printed resources are available to help you quickly learn how to use Extreme 3D.

Most users new to Extreme 3D will benefit from using instructional resources in the following sequence:

1. **Watch the *Learning Extreme 3D* training movies using the Learning Viewer on your application CD.**
   Watching the training movies, you'll see how to understand the 3D environment, create 3D objects and assemble them into models, create an animated sequence, and create lighting effects.

   Many of the files used in the *Learning Extreme 3D* training movies are included in the Examples folder on your application CD. You can open these files in Extreme 3D and work with them to recreate what you've seen in the movies.

2. **Work through the exercise in the tutorial.**
   Chapter One of this manual takes you step-by-step through the production flow of creating an Extreme 3D scene. Using example files and following brief instructions, you'll create a model, animate it, apply materials to it, create lighting effects for it, and render it to a movie file.

3. **When you're working with Extreme 3D, use the status bar for information on how to use tools.**
   The status bar at the bottom of the screen shows tips for using the tool palette's tools, the menu commands and all of Extreme 3D's browsers and dialog boxes. When you're using a tool, refer to the status bar for step-by-step instructions.

4. **If you need a quick reminder about a tool, command, dialog box, or browser, use the Help system.**
   The Help system includes complete reference material for Extreme 3D. To open the Help system, choose Extreme 3D Help from the Help menu, or press F1 (Windows).

5. **For detailed information on Extreme 3D, refer to the other chapters in this manual.**
   This manual provides a complete guide to the features and functions of Extreme 3D, including detailed procedures that you can follow to create almost any effect you want.

6. **If you run into problems, see the Troubleshooting section of the Extreme 3D Help system or the Late Breaking News files, available on the application CD.**

Note: The instructional resources assume that you are familiar with your Macintosh or Windows operating system.

What's new in Extreme 3D

This is a description of the new features in Extreme 3D. For additional information about how each new feature works, choose the What's New topic in Extreme 3D's improved on-line Help system.

Opening existing Extreme 3D files

Existing Extreme 3D files are upwardly compatible with Extreme 3D's new features. Files open without the need for conversion. Some changes to lights and materials, however, might alter aspects of your lighting or materials designs. You might see differences in ambient lights, shadows, or mapping. Following are some suggestions for recreating Extreme 3D 1.0 looks in Extreme 3D 2:

- Ambient lights
  - There is now a default ambient light in the scene. It can be edited in the Lights browser like any other light. The ambient settings you made in Extreme 3D 1.0 using Global Effects are automatically stored in this light and can be edited using the Lights browser.
  - Materials no longer have individual Ambient settings to control each material's response to the Ambient light. Use the new luminosity property in any material to control the effect of ambient light on a per-material basis.
- Shadows
  - Some shadows may look different. Use the new Shadow Resolution control in Distant lights or Spotlights to approximate, or improve, the look of shadows created in Extreme 3D 1.0.

- Mapping types
  - All objects now have a default mapping type. For most objects the default is intrinsic. However, each object changes its default to the correct mapping type according to the material you apply to it. For example, if you apply an Organic Magic material to an object, that object changes its default mapping type to projective to create a solid material look. If you then change your mind and apply a Mondo Map material, the object changes its default back to intrinsic so mapping works correctly.
  - Solid materials, such as Organic Magic and Tiles, can now be used either as solid materials or applied to the surface of objects, like texture maps. To use a solid material like a texture map, change the object's mapping type to intrinsic from default in the Objects browser.
  - Because solid materials in Extreme 3D 1.0 didn't pay attention to the mapping type set for an object, some solid materials in existing files can look different in Extreme 3D 2. Objects with solid materials that happened to be saved in Extreme 3D 1.0 displaying a mapping type other than projective can be corrected by explicitly setting the objects' mapping type to projective in Extreme 3D 2.
- Material properties values
  - Material properties now use color rather than numeric values in the Material editor. The numeric values in existing Extreme 3D files control only the gray scale component of properties. To recreate exact numeric values for properties in existing Extreme 3D files, use the gray scale slider and text fields in the color picker dialog.
- Gamma correction and pre-multiplied alpha
  - In Extreme 3D 1.0 all files were saved by default using pre-multiplied alpha and no Gamma correction. Make sure these options are set to these values in Final Render Setup when rendering an existing Extreme 3D file.

New Web support features

- Extreme 3D now supports several 2D formats useful for exporting Web-ready images. These include:
  - GIF89a (still and animated, transparent and interlaced)
  - Progressive JPEG
  - PNG
  - xRes LRG for the new Shockwave imaging plug-in
- Several 3D file formats are also supported by Extreme 3D for creating 3D worlds and images. These include:
  - VRML 1& 2
  - Apple's 3DMF
- Incorporate VRML 1 and 2 features in Extreme 3D models, such as attaching Anchor, Inline, and Texture URL's to objects, within the Objects browser.
- Extreme 3D's Uniform and Adaptive smoothing features are uniquely suited to creating highly optimized objects and worlds for the web. Use these features to quickly change object resolution for VRML level of detail support. VRML worlds built with Extreme 3D are fully compatible with VRML browsers such as Netscape's Live 3D, SGI's Cosmo, or Intervista's WorldView. Extreme 3D files can also be exported as 3DMF files for Web use.

New Macromedia studio features

- Extreme 3D now supports a number of cross-platform bitmap 2D file formats. These files can be both imported, for use as texture maps and backgrounds, and exported, for use in other applications including Macromedia studio applications. The bitmap file formats that Extreme 3D supports are:
  - BMP
  - GIF
  - JPEG
  - Photoshop 3.0
  - PICT
  - PNG
  - Targa
  - TIFF
  - xRes LRG
- Extreme 3D now supports import of two vector-based 2D file formats. These files are especially useful for importing profiles designed in professional illustration programs for use as defining geometry for Extreme 3D models. You can now drag and drop profiles from FreeHand 7 directly into Extreme 3D. The vector based file formats that Extreme 3D supports are:
  - FreeHand 4, 5 & 7
  - EPSF
- Extreme 3D has further optimized its ability to work with other Macromedia studio applications by implementing a number of its features as extensible Xtras:
  - All file import and export filters
  - Materials
  - Lights
  - VRML (export only)
  - 3DMF

New tools

- The tool palette provides two new tools: the Metaforms tool and the Particle System tool. Apply any of Extreme 3D's materials and use any material animation features with metaforms and particle systems to create a wide variety of new effects.
  - Use the Metaforms tool to create blobby or organic forms that can be animated, like clay models, to break into pieces or flow together.
  - Use the Particle System tool to create complex models like leaves on a tree or behavior-based animations such as floating bubbles, exploding fireworks, and falling rain.

Lights and materials enhancements

- All of Extreme 3D's lights and materials are now Xtras. This means that a wide variety of new functions can be incrementally added to Extreme 3D over time without requiring you to upgrade. Instead, you will be able to check Macromedia's Web site for new lights and materials and download them. Or, if you are a developer, you will be able to write lights and materials Xtras that Extreme 3D can use.
- Two new properties, Transparency and Luminosity, have been added to solid materials, such as Organic Magic, and texture map materials, such as Mondo Map. You can also choose to invert bump maps used in Mondo Map materials to create new effects.
- Designing new materials that use transparency and luminosity is aided by being able to see these effects immediately in the Materials browser preview window.
- Now you can define all the standard material properties, including the new properties of transparency and luminosity, as colors rather than simple gradient steps. By using actual color values, you can create a much wider variety of material looks.
- The Plastic material and Texture map material have been combined into one default material. Look for Generic+Texture in the Materials browser if you want to create a simple texture map or solid material.
- Ambient lights, lights that illuminate all sides of an object in a scene, are now available as a light type in the Light browser. The ambient light settings created using Global Effects in old Extreme 3D files are applied to the default ambient light in the Lights browser.

- Spotlights and Distant lights now provide you with more control over the shadows they create. Use the new Shadow Resolution and Shadow Fuzziness properties to create softer shadows and to optimize memory usage.
- Another addition to Spotlights is a control for enhancing dust shadows and/or light rays. Use these features to achieve better lighting effects with Extreme 3D's improved volumetric lights.

Rendering enhancements

- Extreme 3D's renderer has been completely re-written to take advantage of floating point processing capabilities found in the Power PC and Pentium-class chips. This means that Extreme 3D 2 for Macintosh is a Power Macintosh-only application.
- The Extreme 3D renderer now supports transparency in shadows. As an option in Final Render Setup you can choose to have any material that has a transparency value render that transparency in the shadow of the final rendering. Use this feature to achieve effects usually found only in ray tracers. Extreme 3D can produce effects such as light casting shadows through venetian blinds or lamp shades, but at speeds much faster than comparable effects rendered with ray tracers.
- Gamma Correction is now available as a Final Render Setup option. Adjust gamma according to your final output medium needs and eliminate the need to do gamma correction as a post-processing pass.
- Pre-Multiplied alpha for film and video output is still available and Standard alpha has been added as an option. Use standard if you want to use output images as mattes for compositing in post-production.

Hardware acceleration support

- Extreme 3D is now compatible with system-level renderers. These are:
  - Microsoft's Direct3D (for Windows 95 platforms)
  - Apple's QuickDraw 3D (for Power Macintosh platforms)

  By using QuickDraw 3D or Direct3D, you can take advantage of hardware acceleration to increase interactive rendering speeds. This provides you with fully rendered scenes while you are previewing animations or scene building. All animatable parameters can be previewed in real-time with QuickDraw 3D and Direct3D, including scaling and moving texture maps, and moving objects.
- Extreme 3D's own internal render is still available. With the QuickDraw 3D or Direct3D extensions on, you can choose to take advantage of the improved transparency rendering in one window and view your work in 32-bit shaded mode with the internal renderer in another window.

Windows 95 compliance

Extreme 3D is compliant with Windows 95 logo requirements. For more information about these features, see the Extreme 3D Help system.

Other important features

- Use the new Collect Files feature to collect all the texture (*.TEX) files for a scene. Move them from the Material folder to a folder of your choosing. This reduces the number of texture files that you accumulate in the Material folder, facilitates better archiving of scenes and their associated texture files after a project is completed, and supports multi-user production by making it easier to transfer complete files to other users without having to supply all of the original bitmap textures.
- You can quickly create complicated arrays and multiple linked duplicates with the new Duplicate Special feature. Create windows in a skyscraper or a spiral staircase in a single step.
- The score has two features to facilitate customizing score organization and display. Use the hierarchy to expand and collapse arrows to hide properties that are otherwise exposed using the filters alone. Sort objects into layers in the Layers browser and then use the new Selected Layer object filter type to further organize and manage the score.
- A Find All capability has been added to Edit/Find dialog boxes.

Improved Help

- On-line Help now supports a Help pointer which provides context sensitive help in the workspace.
- A comprehensive index has been added.
- Other on-line additions include electronic documentation built into the Help application that supplements the printed documentation. These include:
  - Overview
  - How to...
  - Reference
  - Troubleshooting

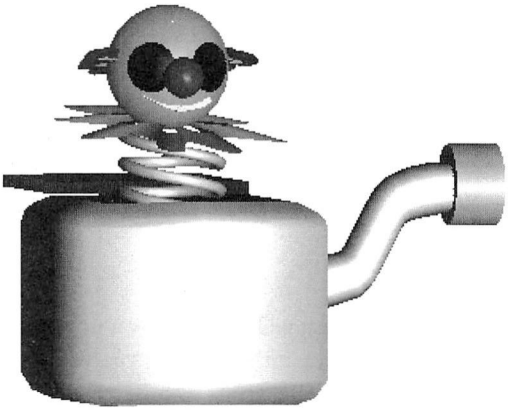
Chapter One
Quick Start

This tutorial is designed as a hands-on introduction to Extreme 3D. Using the examples in this tutorial, you will:

- Learn how to work in three dimensions
- Create the 3D components of a model
- Assemble a model
- Animate a model
- Light a scene
- Apply materials to a model
- Output still and animated files of your work

Meet Jack

When you work through the procedures in this tutorial, you'll make changes and additions to a model of a jack-in-the box.



This model has been created for you—up to a certain point. The box and Jack himself are complete.

The jack-in-the-box model is one of several example models included with Extreme 3D. All example models are located in the Examples folder.

Work with Jack

You'll use the jack-in-the-box model in every section of this tutorial.

- In Getting Oriented, you'll open the model and view it from a variety of angles.
- In Modeling, you'll create the crank that winds up the jack-in-the-box.
- In Assembling a model, you'll attach the crank to the box and link it so it becomes part of the jack-in-the-box model.
- In Animating, you'll animate the model, making the crank turn and Jack jump out of the box.
- In Adding lights, you'll create a spotlight and shine it on the model.
- In Applying materials, you'll create special materials and apply them to the model to get just the right look.
- In Rendering, you'll render a still image and an animated movie to external files.

But first...

Before you begin working through the examples in this tutorial, it's a good idea to watch the *Learning Extreme 3D* movies. You can view the movies from the Learning Viewer, which can be found on your application CD.

About this tutorial

This tutorial makes it easy for you to work through the examples in each of the sections. The steps in each section build on the work you've done in previous sections.

At the end of each section is a topic called "To learn more..." that includes recommendations for further reading in the rest of this manual and pointers to online examples provided on your application CD.

Macintosh and Windows

Because Extreme 3D can be used on both Macintosh and Windows systems, this tutorial includes directions for performing tasks on either platform. Figures include both Macintosh- and Windows-style dialog boxes. These dialog boxes work the same on either system. Differences in keyboard keys are noted as system-specific.

Getting Oriented

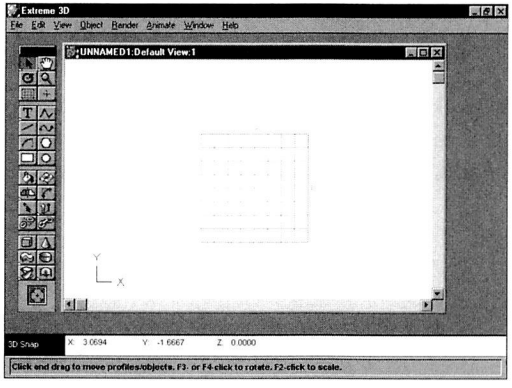
This section discusses the key concepts that help you understand how you can work on a two-dimensional computer screen to create and manipulate objects in three-dimensional space.

- You'll be introduced to the elements of the Extreme 3D world, including the workspace, tool palette, tool space, status bar, and working plane.
- You'll learn how to move objects, either freely or precisely, in the workspace.
- You'll see how to change your view into the 3D world, and how to keep your bearings as you change views and move objects.

If you haven't already done so, now is a good time to watch "Navigating," one of the *Learning Extreme 3D* movies. View the movie from the Learning Viewer, which can be found on your application CD.

Looking at two dimensions

When you launch Extreme 3D, you see a tool palette and a window that contains a visible grid.



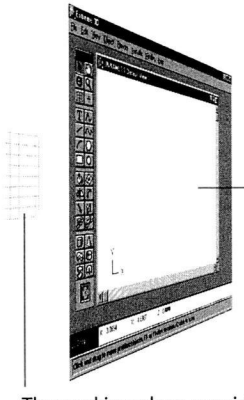
The window is the Extreme 3D ***workspace***. In the center of the workspace is the ***working plane***, which provides a grid you can use as a drawing surface.

As you choose tools and begin to create objects in the workspace, it might seem as though you're drawing on a flat surface—as you would in drawing or painting applications that you might be familiar with. You'll find, however, that you're actually placing objects in three-dimensional space. This three-dimensional space is sometimes called the ***3D world***.

Once you create something, you can look at it from any angle and change its position and orientation in the 3D world.

Thinking in three dimensions

Although the workspace might look like a flat page, you can think of it as a window that frames your view into the 3D world.



You view the 3D world through the workspace window.

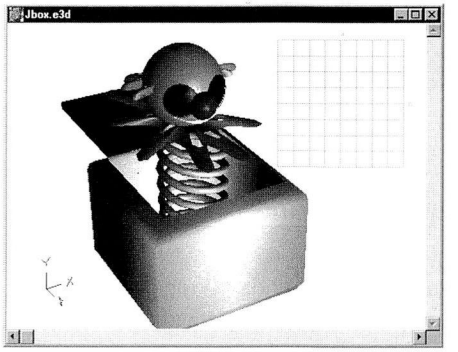
The working plane provides a drawing grid you can use in 3D space.

Beyond the workspace, the 3D world extends infinitely in all directions. The working plane might appear to be a stationary surface, but you can move it freely in the 3D world, positioning and orienting it where you need it.

What you see onscreen

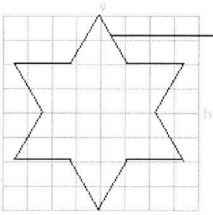
What you see onscreen when you launch Extreme 3D is all you need to get started creating 3D objects and assembling models from them.

- Use the workspace to view objects in the 3D world from any angle.



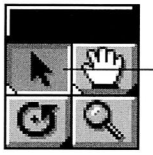
This workspace shows a view from a three-quarter angle of the jack-in-the-box model you'll work with later in this section.

- Use the working plane as a background grid for the objects you draw in the workspace.



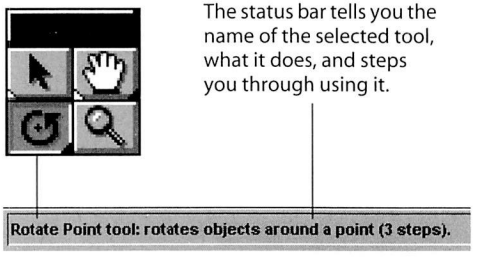
Shapes like this star would be hard to create without the grid of the working plane.

- Use the tool palette to create and customize objects in the workspace.



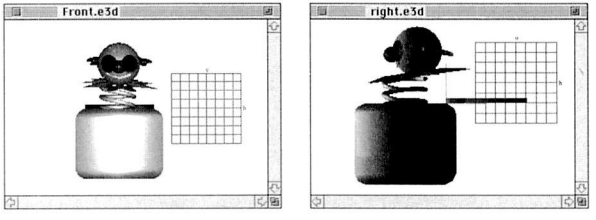
The arrow tool is selected by default. Click any other tool to use it.

- Use the status bar for information on what tools do and how to use them.



Using the working plane

The working plane gives you an easy way to create 3D objects as if you were working on a 2D surface. The working plane is always present in the workspace. By default, the working plane automatically adjusts itself to remain parallel to the workspace, so however you adjust your view into the 3D world, you still look straight at the working plane.



Whether you view the jack-in-the-box model from the front or from the right, the working plane automatically adjusts to face you.

There are ways to turn the display of the working plane off (although it still remains present in the workspace) and to turn off its automatic adjustment. For most of the exercises in this tutorial, it's a good idea to leave the working plane displayed and the automatic adjustment active.

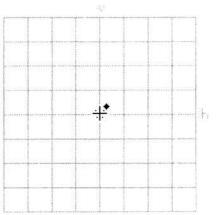
Using tools

The tool palette contains all the tools you need to create and customize objects. Most of the time you use a tool by clicking it to select it, then drawing in the workspace.

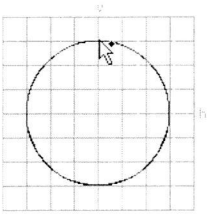
For example, if you want to create a circle:

1 **Click the circle tool.**
Remember, if you aren't sure which tool is which, move your pointer over a tool and refer to the status bar. When you select the circle tool, the cursor changes to a crosshair.

2 **Click in the workspace to specify the circle's center.**



3 **Click again to specify the circle's radius.**
When you click a second time, Extreme 3D draws the circle.



The circle's red color indicates that it is selected when it is created. To deselect it, click anywhere in the workspace. To select it again, click directly on it. You can tell when the pointer is over the circle because a hollow diamond appears next to the pointer.

You'll create several circles in the next few procedures. If you want to delete them as you go along, simply press the Delete key while the circle is selected in the workspace.

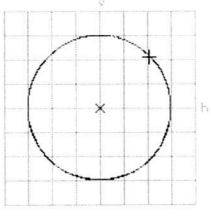
Using the center-corner toggle

You can also create a circle simply by clicking and dragging in the workspace with the circle tool. The tool palette includes a toggle you can use to specify whether you want objects you drag to be created from the center outward, or from corner to corner.

To see the difference between these two methods:

1 **Set the center-corner toggle to the center method.**
This tells Extreme 3D that you want to click at the center of the circle, and drag out to the edge.

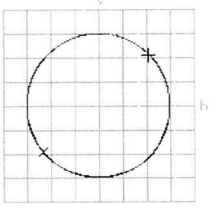
2 **Click the circle tool, then click and drag in the workspace.**



An X marks the center of the circle, where you clicked. You'll see the circle onscreen as you drag. Release the mouse when the circle is the size you want.

3 **Now set the center-corner toggle to the corner method.**
This tells Extreme 3D that you want to click one side of the circle and drag to the other side.

4 **Click the circle tool, then click and drag in the workspace.**



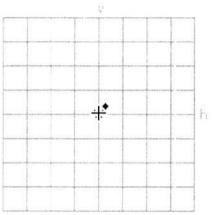
An X marks the side of the circle where you clicked. You'll see the circle onscreen as you drag. Release the mouse when the circle is the size you want.

Using the tool space

The tool space is the text entry area located right above the status bar. You can use the tool space to create objects with precise dimensions.

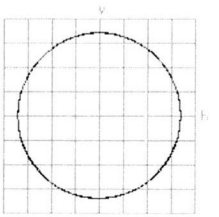
For example, to create a circle with a specific radius:

1 **Click the circle tool, then click to specify the circle's center.**



2 **Press Tab to activate the tool space, then type a value for the circle's radius.**

3 **Press Enter**
Extreme 3D draws the circle with the radius you specified.



Using the status bar

You might have noticed that when you used the circle tool in the previous example, step-by-step instructions appeared in the status bar at the bottom of the screen. These instructions appear for all tools. Refer to them for information about using a tool.

Using tool groups

Some tools have a dark notch in the lower right corner, indicating they are part of a tool group. When you click and hold the notch, the tool group appears. You can then click the tool you need. The tool you click moves to the top of the group and becomes active.

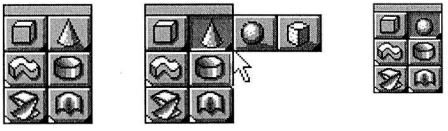
For example, suppose you want to create a sphere. The sphere tool is located in the 3D primitives tool group on the tool palette. The sphere tool isn't visible, but the cone tool is.

To choose the sphere tool and create a sphere:

1 **Click and hold the cone tool.**

2 **Drag the mouse to the sphere tool.**

3 **Release the mouse.**
The sphere tool is now active.



4 **Click in the workspace.**
Extreme 3D creates a default-sized sphere.

Moving objects

You can move objects anywhere in the 3D world. Use the arrow tool and the mouse to drag objects, or select an object and use the arrow keys to nudge it by small increments.

Dragging with the arrow tool

You can move objects freely in 3D space using the arrow tool.

To move the sphere you created in the previous procedure:

- Select the arrow tool, then click and drag the sphere to the position you want. As you drag, Extreme 3D shows the sphere's bounding box. This way you can quickly get an idea of where the object will appear when you release the mouse.

You can select more than one object using the arrow tool, and then move them all at once.

To move several objects:

1 **First, create an additional sphere, or create a cone or cube using the same method you used to create the sphere.**

2 **Select the arrow tool and hold down the Shift key, then click to select each object you want to move. Drag the objects to the positions you want.**

Tip: If the objects you want to select are adjacent, you can select the arrow tool and click and drag a marquee around them to select them. Then you can click one of the objects and drag them all to the position you want.

Nudging with the arrow keys

When you want to move an object precisely, in small increments, you can use the arrow keys on your keyboard. This is called ***nudging*** the object.

To nudge an object:

- Select the arrow tool and click the object you want to move, then press the Left, Right, Up, or Down arrow keys to move the object.

Controlling movement

There are times when you need to control an object's movement. For example, you might want to move it horizontally, but make sure you don't accidentally move it vertically. When this is the case, you can use keys on your keyboard while either dragging with the arrow tool or nudging with the arrow keys.

When you control object movement with the keyboard, Extreme 3D uses the working plane. By default, the working plane adjusts to face you every time you change your view. Because of this, Extreme 3D can use the working plane's axis to control movement.

- Hold the H key when you want to make sure you move an object only left or right horizontally.
- Hold the V key when you want to make sure you move an object only up or down vertically.
- Hold the N key when you want to make sure you move an object along the z-axis of the working plane—toward you or away from you.

Closing a file

You'll use the jack-in-the-box model for the remaining procedures in this tutorial, so you can close the file you've been working with so far.

- Choose Close from the File menu. Extreme 3D prompts you to save the file. Choose No to close the file without saving it.

Changing your view

Using ***preset views*** from the View menu, you can quickly change your view into the 3D world.

Experiment with changing views using the jack-in-the-box model.

To open the jack-in-the-box model:

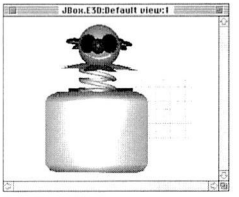
1 **Choose Open from the File menu.**

2 **Move to the Examples folder, then choose Jbox.E3D.**
The jack-in-the-box model opens.

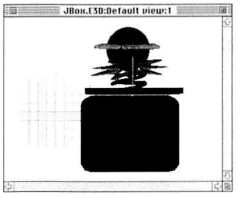
When you open the jack-in-the-box model, you're viewing it from the front. Using the commands from the View menu, you can view the model as if you're moving around it in 3D space.

To move around the model:

- Choose Back from the View menu, then choose Left, Right, Three-quarters, and Top.

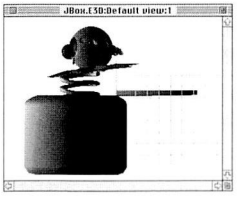


Front

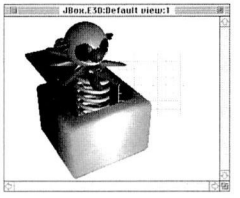


Back

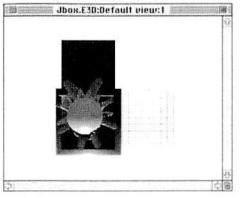
Left



Right



Quarters



Top

Note: When you change your view, the model might appear partially outside the workspace window. If this happens, you can choose Fit to Window from the View menu. Extreme 3D then centers the model in the workspace.

Creating a custom view

If the preset views don't provide exactly the view you want, you can use the hand tool and the zoom tool to create custom views.

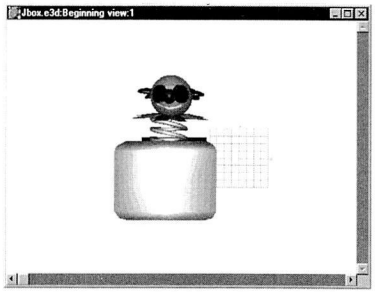
Using the hand tool

When you select the hand tool from the tool palette, you can click and drag in the workspace to move your view freely in 3D space.

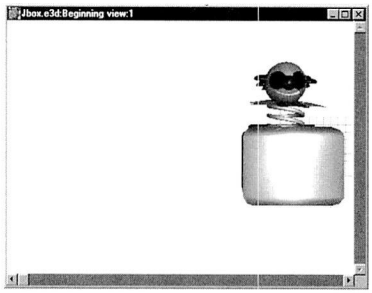
When you use the hand tool, it might feel like you're moving the model, but you're actually adjusting the position and angle of your view of the workspace. The model remains stationary—it's your view that changes.

To experiment with the hand tool:

1 **With the jack-in-the-box model open, choose Front from the View menu, then choose Fit to Window from the View menu.**
Extreme 3D centers the model within the view of the workspace window.



Before you use the hand tool, you're looking straight at the model from the front.

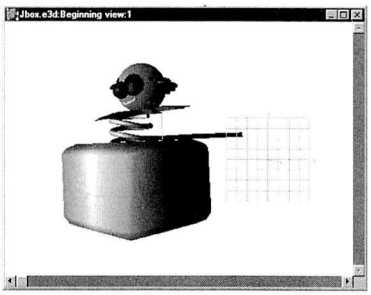


After you drag with the hand tool, you're looking at the model from a different position, at a slight angle.

2 **Select the hand tool, then click in the workspace and drag to the right.**
If you want, you can click on the model and drag, but it doesn't really matter where you click because you're not moving the model, you're changing the position and angle of your view.

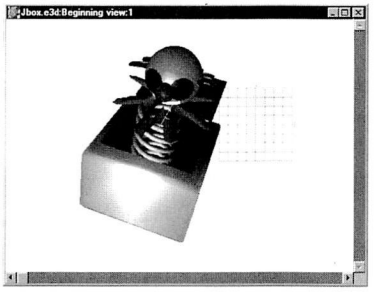
As you drag, Extreme 3D shows the bounding boxes of the objects that make up the model. This way you can quickly get an idea of how your view will change when you release the mouse.

3 **Select the hand tool and hold the F3 or F4 key (Windows) or Option or Command key (Macintosh), then click and drag to the left.**



Because you're holding the key while dragging, Extreme 3D rotates your view of the model.

4 **Select the hand tool and hold the F3 or F4 key (Windows) or Option or Command key (Macintosh), then click and drag downward.**



The position from which you're now viewing the model might be different from this picture, depending on which keys you held and how far you dragged.

Using the zoom tool

When you want to view a model or a portion of a model more closely, use the zoom tool. When you use the zoom tool, you don't move the model closer—you move closer to the model.

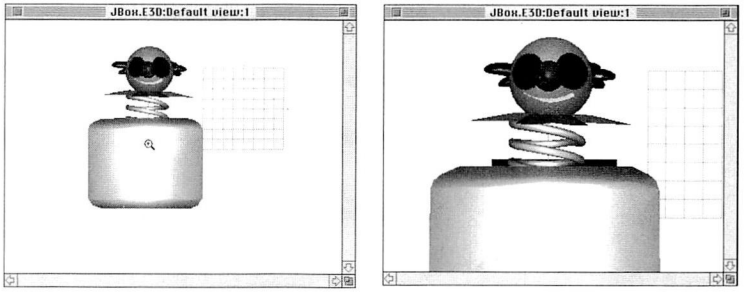
To use the zoom tool:

1 **With the jack-in-the-box model open, choose Front from the View menu.**

2 **Choose Fit to Window.**
Extreme 3D centers the model within the view of the workspace window.

3 **Select the zoom tool**
When you click the zoom tool, the cursor changes to the shape of a magnifying glass with a plus sign in it.

4 **Click the jack-in-the-box model.**

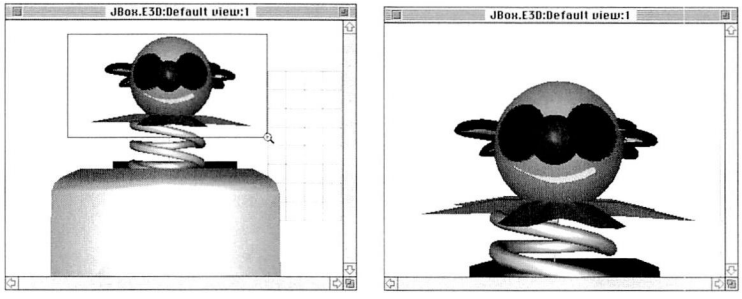


When you click with the zoom tool, Extreme 3D moves your view in closer on the model.

Using the zoom tool, you can also zoom in on a specific area of a model.

To zoom in on Jack's head:

1 **Select the zoom tool, then click and drag a box around the head.**



When you release the mouse, Extreme 3D moves your view in closer on the area you selected.

To zoom out, press the F3 (Windows) or Option (Macintosh) key while using the zoom tool. The magnifying glass cursor changes, displaying a minus sign instead of a plus sign. (If you don't see the minus sign, move the mouse slightly to make it appear.)

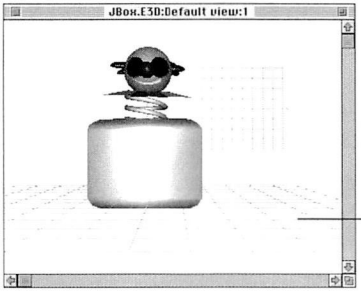
Using the ground plane

Because you can move and view objects from any angle in the 3D world, Extreme 3D provides a ground plane to help you keep your bearings.

The ground plane does not appear by default.

To display the ground plane:

- Choose Show Ground Plane from the Object Menu to check the command.



The ground plane appears as a blue grid.

Note: You might need to choose Fit to Window from the View menu to see the ground plane.

The ground plane always remains in the same place. You can't select it or move it. Because it's stationary, the ground plane gives you a strong visual reference when you're working in 3D space.

Because you don't need the ground plane just now, you can turn off the display.

To turn off the display of the ground plane:

- Choose Show Ground Plane from the Object menu to uncheck the command.

To learn more...

For more information about working in three dimensions, changing your view, and customizing your work environment, see Chapter Two, "Navigating the workspace."

Modeling

Modeling is the process of creating 3D objects. You can use a variety of tools and techniques to model objects in Extreme 3D. This section walks you through one method of modeling a handle for the jack-in-the-box.

In this section, you'll see how to:

- Hide objects so you can work in an uncluttered workspace
- Create a 3D object using the sweep tool
- Modify the swept object you create
- Create a 3D object using the extrude tool

If you haven't already done so, now is a good time to watch "Modeling," one of the *Learning Extreme 3D* movies. View the movie from the Learning Viewer, which can be found on your application CD.

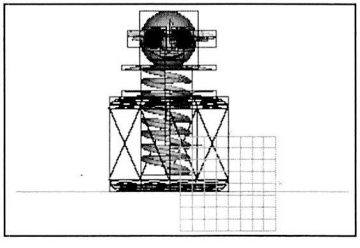
Hiding the jack-in-the-box

When you're working on a complex model, you might have dozens of objects in view in the workspace at one time. Hiding some objects can make it easier to concentrate on the object you're working on.

Tip: Hiding objects also speeds screen refresh time.

To hide the jack-in-the-box model while you create a new part for it:

1 **With the jack-in-the-box file open, select the arrow tool, then drag a marquee around the jack-in-the-box.**



2 **Choose Hide from the Object menu, then choose Selected Objects.**
The jack-in-the-box remains present in the 3D world, but is hidden from your view. Extreme 3D protects you from selecting or manipulating a hidden object, so you can't inadvertently change the hidden jack-in-the-box.

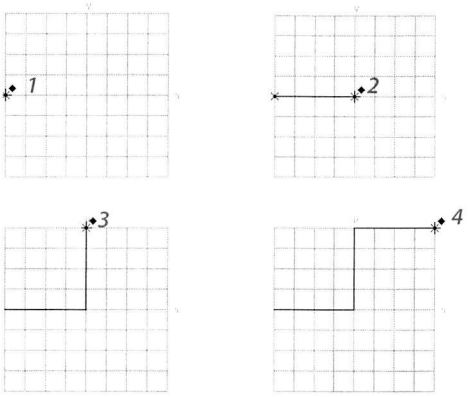
Creating the jack-in-the-box crank

You can model objects any number of ways using Extreme 3D. In this exercise, you'll use the sweep tool to create a crank for the jack-in-the-box model.

To create the crank:

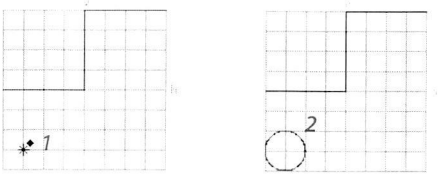
1 **Select the polyline tool.**
Using the polyline tool, you'll create a line that defines the shape of the crank.

2 **Click three points on the working plane, as shown in the figure below. Double-click the fourth point to create the polyline.**
2D lines and shapes that are used as the basis for 3D objects are called *profiles*.



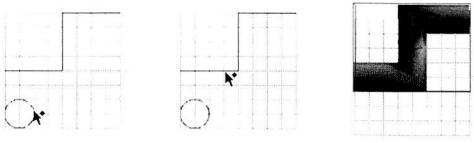
3 **Select the circle tool.**
The circle you create will define the width of the crank.

4 **Click a point on the working plane, then drag to create a circle that fits within four grid squares.**



5 **Select the sweep tool.**
When using the sweep tool, watch for the hollow diamond to appear as you move the pointer over the profile of the circle. The diamond tells you you're over a profile.

6 **First click the circle, then click the polyline.**
Extreme 3D sweeps the circle along the polyline, creating the three-dimensional crank.



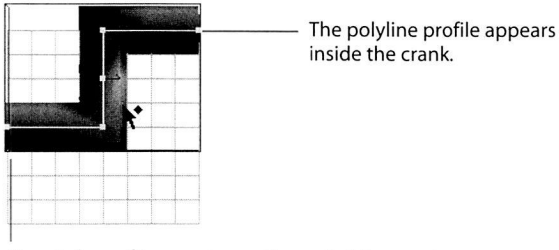
Editing the jack-in-the-box crank

After you create an object, the profiles that define its underlying structure remain available. You can edit these profiles to change the shape of the object.

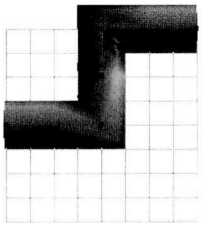
The crank you created in the previous exercise has sharp angles. In the next exercise, you'll smooth the angles, creating a more real-world look for the crank.

To change the shape of the crank:

1 **Double-click the crank.**
Extreme 3D displays the polyline and circle profiles that were used to create the crank. These profiles are the crank's *defining geometry.*

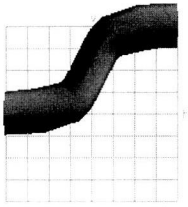


2 **Click a control point on the polyline profile.**
This isolates the polyline as the part of the object that the next command will effect.



Selected control points are red. Unselected control points are blue. The object's center point is green.

3 **Choose Smooth Polylines from the Object menu.**
Extreme 3D changes the shape of the polyline, smoothing its angles.

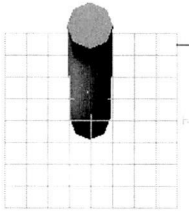


Because the polyline defines the shape of the crank, smoothing its angles smooths the angles of the crank as well.

Creating the jack-in-the-box knob

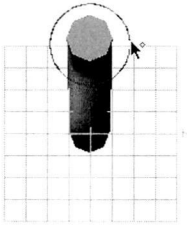
The crank part of the handle is finished. To complete the handle, you need to add a knob.

1 **Choose Right from the View menu.**
You might need to use the hand tool to see the crank as it is shown below.

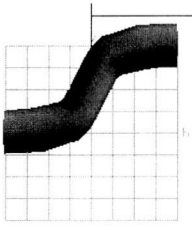


The working plane automatically adjusts to face the screen. It goes through the center of the crank.

2 **Select the circle tool from the tool palette, then click and drag to create a circle that is approximately twice the diameter of the end of the crank.**
This might be easier if the center-corner toggle is set to the center method of drawing.

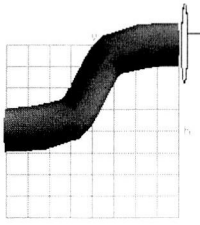


3 **Choose Front from the View menu, then click in the workspace to deselect the circle and choose Fit to Window from the View menu.**



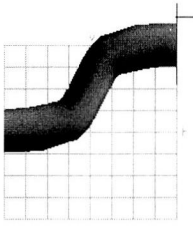
The circle you created is in the center of the crank. This is because the circle was drawn on the working plane, and the working plane was located in the center of the crank.

4 **Select the circle and use the Right arrow key to nudge the circle to the end of the crank.**



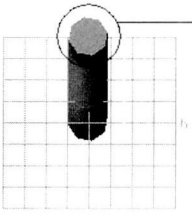
Because Extreme 3D shows perspective, the circle appears to turn slightly as you nudge it.

5 **Choose Perspective from the View menu, then choose Orthographic.**



Because the Orthographic setting turns off the display of perspective, you can nudge the circle into perfect alignment.

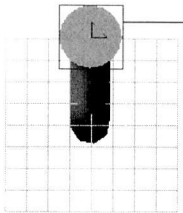
6 **Choose Right from the View menu.**



You might need to nudge the circle to center it exactly around the end of the crank.

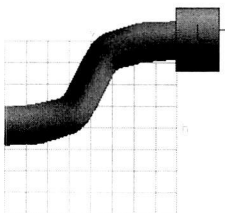
7 **Select the extrude tool.**
The extrude tool looks a little like the cube tool. Refer to the status bar to make sure you're selecting the extrude tool.

8 **Press Tab to move to the tool space, then type the value 0.5 and press Enter.**



The circle is extruded to become a cylinder with a depth of 0.5 inches.

9 **Choose Front from the View menu.**



The cylinder knob appears at the end of the crank.

Now that you've finished creating the handle, return to viewing perspective.

To display perspective:

- Choose Perspective from the View menu, then choose Narrow.

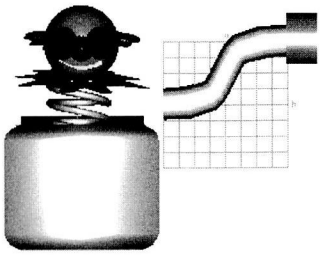
Saving your changes

Now that you've created the jack-in-the-box handle, you can make the jack-in-the-box visible again and save your changes.

Showing the jack-in-the-box

To display the jack-in-the-box model again:

- Choose Show from the Object menu, then choose All.



The jack-in-the-box appears in the workspace.

Note: You might need to choose Fit to Window from the View menu to see the entire model.

Hiding extra objects

When you choose to show all objects, some extra objects appear in the workspace. Since you don't need them now, it's a good idea to hide them.

- Choose Hide from the Object menu, then choose Camera. Choose Hide from the Object menu again, then choose Construction Objects. Finally, Choose Hide from the Object menu again, then choose Trim Curves.

Note: You might need to choose Fit to Window from the View menu again after you've hidden these unwanted objects.

Saving a copy of the model

It's often a good idea to save your model at various stages of development. Saving each stage as a separate file and numbering them can be a good production strategy.

To save this version of the jack-in-the-box model:

1 **Choose Save As from the File menu.**

2 **Save the file as Jbox1.E3D.**
E3D is the standard extension for files created using Extreme 3D.

To learn more...

You can model almost anything—from the simplest to the most sophisticated object—using Extreme 3D. For more information about creating models, see Chapter Three, "Modeling."

Extreme 3D comes with many example models in addition to the jack-in-the-box you've been working with. These models are installed in your Examples folder. You can open and work with any of these models.

Assembling a model

Most models are constructed of a number of parts that you move and align until they have the correct relationship to one another. This section shows the process of attaching the handle to the box of the jack-in-the-box model.

In this section, you'll learn how to:

- Link objects to create a model
- Use construction objects
- Cut and paste objects
- Link objects for animation

Linking the parts of the handle

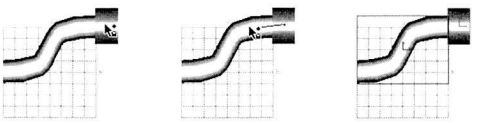
You can assemble a model from several objects by linking them.

Begin with the Jbox1.E3D file that you saved at the end of the previous section.

To link the knob to the crank:

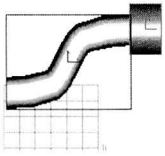
1 **Select the lock link tool from the link tool group on the tool palette.**
Links hold a model together and define how objects can move in relation to one another. Each of the link tools creates a different kind of link. The lock link is the most restrictive kind of link.

2 **Click the knob and drag a line to the crank.**



The knob is now linked to the crank. This is indicated by the selection rectangles around both objects. The crank is the ***parent*** in the linked relationship, and the knob is the ***child***. A child object displays a gray selection rectangle whenever its parent is selected.

3 **Select either the knob or the crank and move the assembled handle to the upper right corner of the workspace.**



Because the knob and crank are linked with a lock link, one moves when the other moves.

Attaching the handle

You've already seen how easy it is to move objects in the workspace. Although you could simply move the handle to the side of the box, it's important to position and attach it with great precision in order for it to work properly when you animate it. Attaching the handle involves several steps:

- You'll create a temporary placeholder—a construction point—on the side of the box where the handle should attach.
- You'll move the center point of the handle—part of its defining geometry—to the end of the handle where it should attach to the box.
- You'll replace the temporary construction point with the handle's center point, placing the handle exactly where it should be.
- You'll create a special link that allows you to rotate the handle.

Creating a construction point

You've seen that when you change views, the working plane automatically adjusts to face you. Extreme 3D positions the objects you create to be parallel to the working plane. When you want to create an object in a specific position, and that position is not parallel to the working plane, you must change the behavior of the working plane.

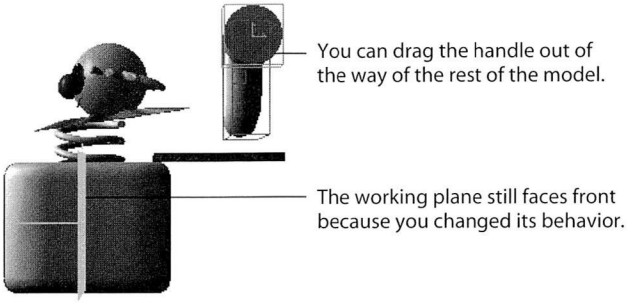
In this procedure, you need to place a construction point on the side of the box. It doesn't matter where the working plane is, only where the box is, so you must disable the working plane's control over object positioning.

To change the working plane's behavior:

- Choose Auto Working Plane to View from the Object menu. This unchecks the command and causes the working plane to retain its current orientation even when you change your view.

Now you're going to position the construction point on the jack-in-the-box.

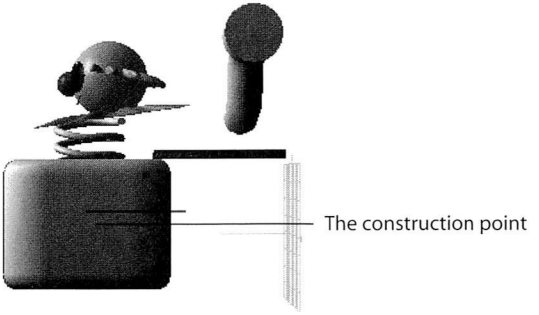
1 **Choose Right from the View menu.**
You might need to use the hand tool or the zoom tool to see all of the jack-in-the-box.



Tip: If you want, you can drag the working plane out of the way of the model.

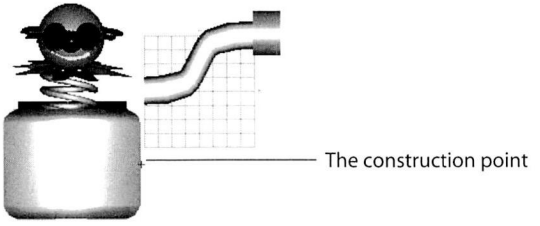
2 **Select the construction point tool.**
The cursor changes to a crosshair in the workspace

3 **Hold the 3 key (this causes the object you create to snap to three-dimensional objects) and click the center of the side of the box.**
Because you hold down the 3 key, the construction point snaps to the surface of the box.



Tip: If the construction point doesn't snap to the correct spot the first time you try, you might need to rotate your view slightly, then try again.

4 **Choose Front from the View menu.**



Tip: If for some reason the construction point you placed does not appear as where it is shown in the two pictures above, you can drag while holding the 3 key down to snap it to its correct position on the box. You might want to switch between the right and front views to check the point's position.

Now that you've positioned the construction point, you can return the working plane to its standard behavior.

- Choose Auto Working Plane to View from the Object menu.

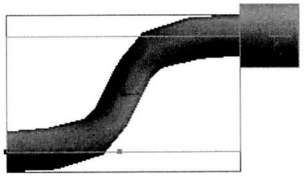
Preparing the handle

In addition to standard cut, copy, and paste commands, Extreme 3D gives you the ability to paste an object to a specific position—the position of a selected object. This is called ***paste-replace***.

You'll use this technique to replace the construction point you just created with the center point of the handle. But before you do that, you need to reposition the handle's center point, moving it to the end of the handle where you want it to attach to the box.

To reposition the handle's center point:

1 **Select the zoom tool and zoom in on the handle, then double-click the handle.**



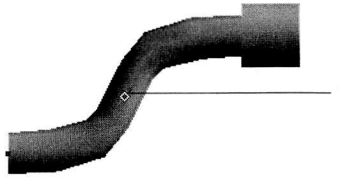
When you double-click, you'll see the handle's defining geometry.

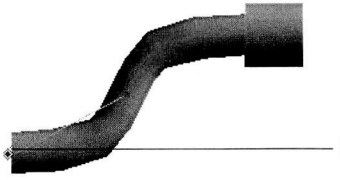
2 **Click in the workspace to deselect the handle.**
The handle's defining geometry remains visible. The green dot is the handle's center point.

Note: Depending on your view, you might not see the green dot of the handle's center point, but that isn't important. You don't need to see the center point to move it, because the move object center tool finds it for you.

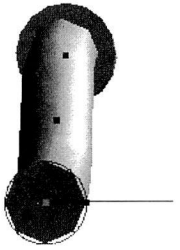
3 **Select the move object center tool.**
The move object center tool is in the control point tool group, under the control point tool.

4 **Click anywhere on the handle and drag to the end of the handle to move the center point to that location.**
Don't worry if you can't see the center point: you don't have to select the center point to move it. Release the mouse when the diamond-shaped cursor is in the correct position. Don't click on any blue control points.





5 **Choose Left from the View menu to make sure you've moved the center point to the center of the end of the handle.**
Continue using the move object center tool until the center point is positioned as shown in the following figure. If the jack-in-the-box model is blocking the view of the handle, you might want to hide it, then show it again after repositioning the center point.



Note: Not only does moving the handle's center point help you position the handle perfectly, it will also make the handle behave properly when you animate it in the next section.

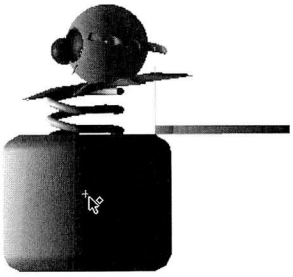
Pasting the handle into place

Now you're ready to replace the construction point on the box with the handle's center point. This will position the handle on the side of the box.

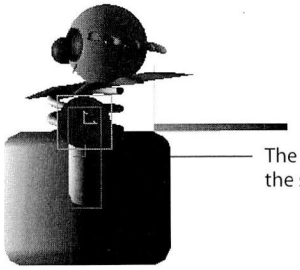
1 **Select the handle and choose Cut from the Edit menu.**

2 **Choose Right from the View menu.**
You might need to choose Fit to Window from the View menu to see the jack-in-the-box model.

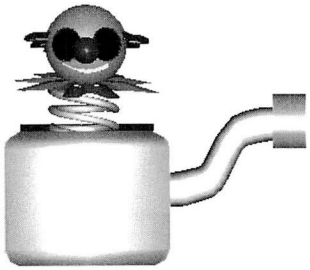
3 **Select the construction point that you placed earlier.**



4 **Choose Paste from the Edit menu.**



5 **Choose Front from the View menu.**



You can see that the handle is positioned correctly.

Linking the handle for rotation

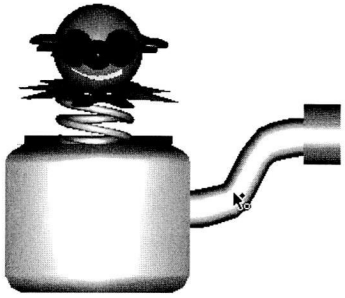
The lock link you created earlier in this section is only one kind of link available from the link tool group on the tool palette.

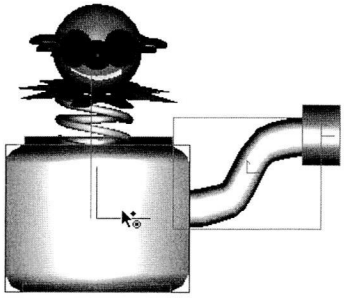
In this exercise you'll use the ball-joint link tool. This tool creates a link that allows the handle to rotate independently of the jack-in-the-box, but not to move independently of it. Because of the ball-joint link, you'll be able to create an animation of the handle rotating when you work through the exercises in the next section.

To link the handle to the jack-in-the-box:

1 **Select the ball-joint link tool.**
The ball-joint link tool is in the link tool group on the tool palette.

2 **Click the handle and drag a line from the handle to the Jack-in-the-box.**





Save your progress

Now that you've positioned and linked the handle, it's a good idea to save your work.

- Choose Save As from the File menu and save this version of the jack-in-the-box as Jbox2.E3D.

To learn more...

There are many techniques for assembling models, and the way you assemble the components of a model can affect how you are later able to animate it.

To learn more about assembling models, see Chapter Three, "Modeling."

Animating

In this section, you'll animate the jack-in-the-box model. Working through the examples, you will:

- Play an existing animated sequence—the lid closing and opening—to see how animation works in Extreme 3D
- Animate the visibility of Jack—making him disappear when the lid is closed
- Rotate the crank you worked with in sections Two and Three
- Animate motion—making the model jump as Jack pops out
- Open the Score to see how Extreme 3D manages the animation you create

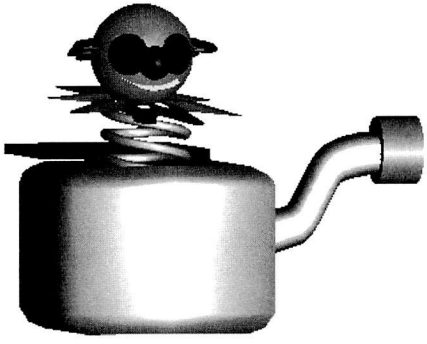
If you haven't already done so, now is a good time to watch "Animating," one of the *Learning Extreme 3D* movies. View the movie from the Learning Viewer, which can be found on your application CD.

Playing an animation

The jack-in-the-box model you've been working with already has some animation included with it. If you like, you can continue to use the model you've been working on. If you haven't worked through the exercises in the two previous sections to create and attach the crank, you can use a new model that already includes the crank.

To open the new jack-in-the-box model:

1. **Choose Open from the File menu.**
2. **Move to the Examples folder, then choose Jboxani.E3D.**
   You'll see a jack-in-the-box model with a crank attached.

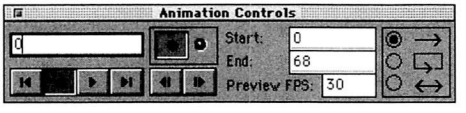


Using animation controls

To play the model's animation, open Extreme 3D's animation controls.

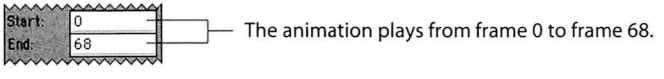
To open the animation controls:

- Choose Animation Controls from the Animate menu.



You can use the animation controls to move around in an animated sequence.

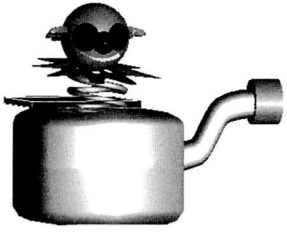
Extreme 3D creates animation by storing information in a sequence of ***frames***. In this file, the animation controls are set to play 68 frames of animation.



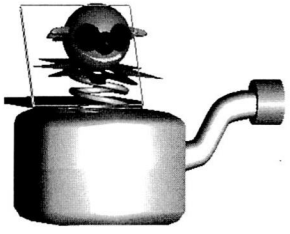
The animation that already exists for the jack-in-the-box model closes the lid, waits, then opens the lid again.

To view the animation:

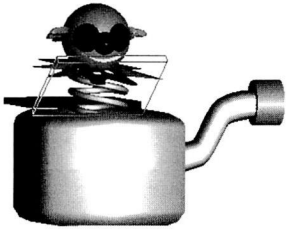
- Press the Play button on the animation controls. Extreme 3D moves the model frame-by-frame through the animated sequence.



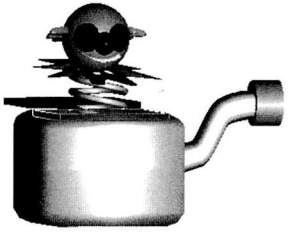
By default, Extreme 3D shows only the animation of an object's bounding box.



You'll see the lid's bounding box raise.



The lid moves through the model of Jack.

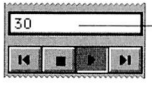


The bounding box shows the lid closing completely during the animation.

The animation happens quickly, so you might want to view it again.

- Using the animation controls, press Rewind, then press Play again. When you rewind the animation, Extreme 3D returns the model to its beginning—Frame 0.

This time when you watch the animation, notice that the Current Frame field of the animation controls shows each frame number as it is played.



The current frame appears as the animation plays.

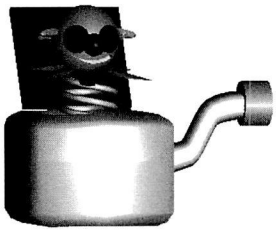
You can step through an animation one frame at a time using the Step Forward and Step Back buttons on the animation controls.

To move one frame at a time:

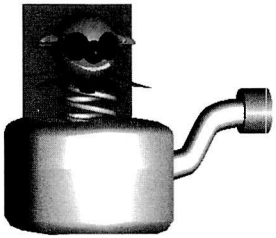
1 **Press Rewind to return to frame 0.**

2 **Press Step Forward.**
Extreme 3D moves the model to its position in frame 1.

3 **Press Step Forward again to move to frame 2.**



When you move one frame at a time, Extreme 3D displays the model moving, not just its bounding box.



Because the model is moving, it takes longer to move from frame to frame using Step Forward and Step Backward.

4 **Press Rewind to return to frame 0.**

Hiding and showing Jack

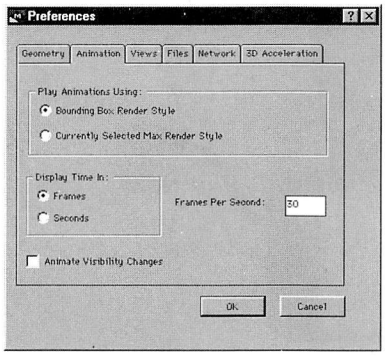
You can see when you play the animation that the lid moves through the model of Jack. The first effect you'll animate is hiding Jack as the lid comes down.

Setting your animation preference

By default, Extreme 3D doesn't recognize changes in visibility as something that can be animated. You can change this setting using the Preferences dialog box.

To change the animation setting:

1 **Choose Preferences from the Edit menu.**
Extreme 3D opens the Preferences dialog box.



2 **Click the Animation page.**

3 **Check Animate Visibility Changes.**

4 **Choose OK.**
Now Extreme 3D is set to record changes in any object's visibility as part of an animated sequence.

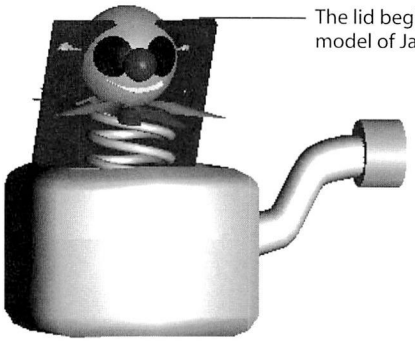
Hiding Jack

When you create an animated effect, you first specify where in the sequence you want the effect to end. You do this by moving to a specific frame. You could use the Step Forward or Step Backward buttons, but a faster way to move to a frame is to type the frame number in the Current Frame field.

When you create an animation effect at a particular frame, that frame becomes a *keyframe*.

To move to frame 3:

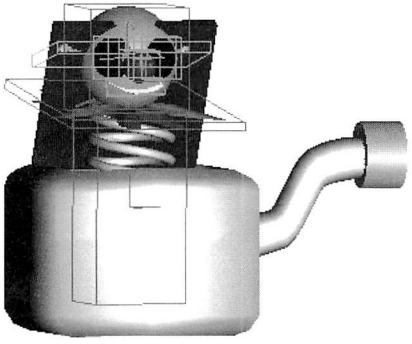
- Type 3 in the Current Frame field of the animation controls, then press Enter. Extreme 3D moves the model to its position at the third frame.



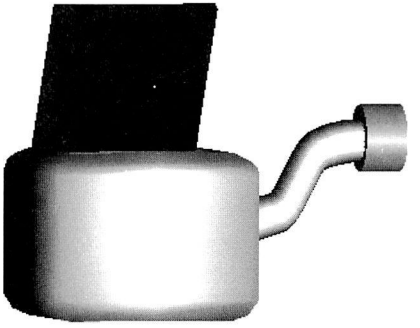
To make Jack disappear as the lid closes, you need to hide Jack at the third frame.

To hide Jack, first select the parts of the model you want to hide:

1. **Using the arrow tool, click Jack's head.**
   Because the eyes, nose, mouth, and hair are all linked to the head object, they become selected with gray bounding boxes when you select the head.
2. **Hold down Shift and click Jack's collar.**
   If you accidently click an object you don't want to select, click that object again while holding down Shift to deselect it.
3. **While still holding down Shift, click Jack's spring.**
   Now all the objects you want to hide are selected.



4 **Choose Hide from the Object menu, then choose Selected Objects.**
The head, collar, and spring are hidden.



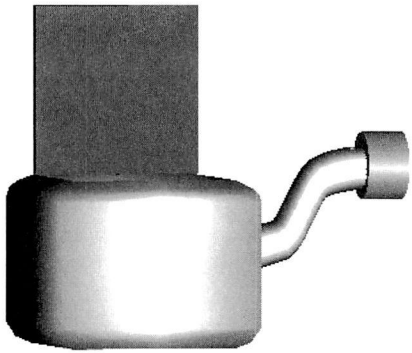
Now that you've hidden Jack at the right time in the animation, rewind and play the animation to see the effect. Because you are previewing the animation in bounding box render style, Jack doesn't disappear, but his selection handles do. When you render the final animation, you will see the visibility changes.

Showing Jack

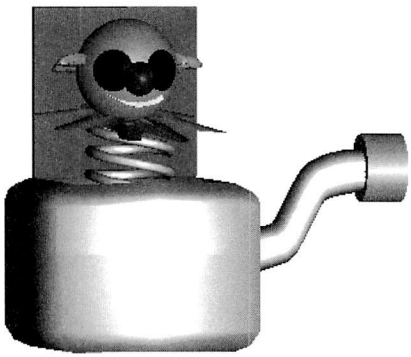
If you stop the animation any time after the third frame, you'll see that Jack has disappeared. Now you need to move to the frame where you want him to reappear.

To make Jack reappear as the lid opens:

1 **Type 60 in the Current Frame Field of the Animation Controls.**
Extreme 3D moves to the 60th frame.



2 **Choose Show from the Object menu, then choose All.**
Jack reappears in the box.



You might see extra objects in the workspace after choosing to show all objects.

To hide extra objects:

- Choose Hide from the Object menu, then choose Camera. Choose Hide from the Object menu again, then choose Construction Objects. Finally, Choose Hide from the Object menu again, then choose Trim Curves.

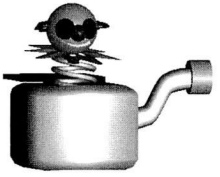
Now you can rewind and play the animation again to see Jack disappear as the lid closes, and reappear as the lid opens.

Turning the crank

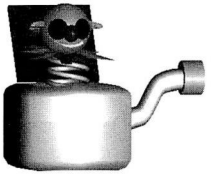
The next effect you'll animate is turning the crank of the jack-in-the-box.

The crank should rotate while the lid is closed—from frame 5 to frame 59—but you don't have to specify a position for the crank in every frame. Instead, you can use the Auto Rotate command.

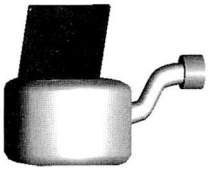
When you use Auto Rotate, Extreme 3D automatically generates keyframes with the correct settings. This makes it easy to rotate objects predictably and in a consistent direction simply by specifying an axis and the number of degrees of rotation.



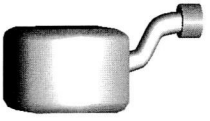
frame 0



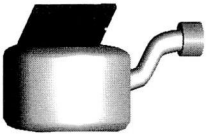
frame 2



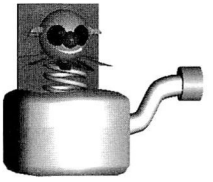
frame 3



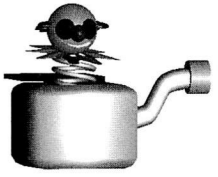
frames 5 to 58



frame 59



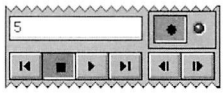
frame 60



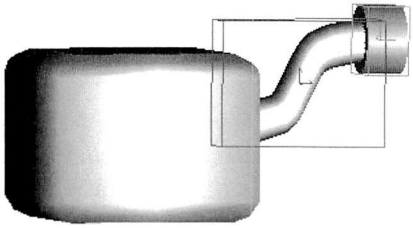
frames 62 to 68

To rotate the crank:

1 **Type 5 in the current frame field of the animation controls, then press Enter.**
Frame 5 is the frame at which the crank should start turning.

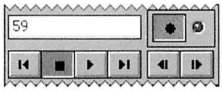


2 **Using the arrow tool, select the crank handle.**
Because the knob is linked to the handle, it becomes selected with a gray bounding box.

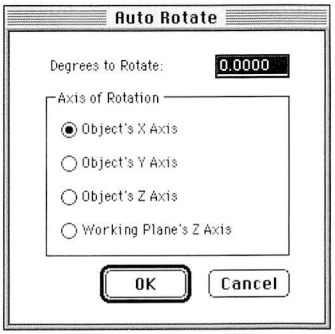


3 **Hold F4 (Windows) or Command (Macintosh) and press the Down arrow.**
This tells Extreme 3D to rotate the handle very slightly toward you between frame 0 and frame 5. This movement won't be noticeable in the final animated sequence; it only serves to set the beginning position of the full crank rotation. If you don't set this position, Extreme 3D assumes you want the full rotation to begin at the beginning of the animation—frame 0.

4 **Type 59 in the Current Frame field of the animation controls, then press Enter.**
Frame 59 is the frame at which the crank should stop turning.



5 **Choose Auto Rotate from the Animate menu.**
The Auto Rotate dialog box opens.



6 **Type 1080 in the Degrees to Rotate text field.**
Specifying 1080 makes the crank rotate three times between the current keyframe (59) and the previous keyframe (5).

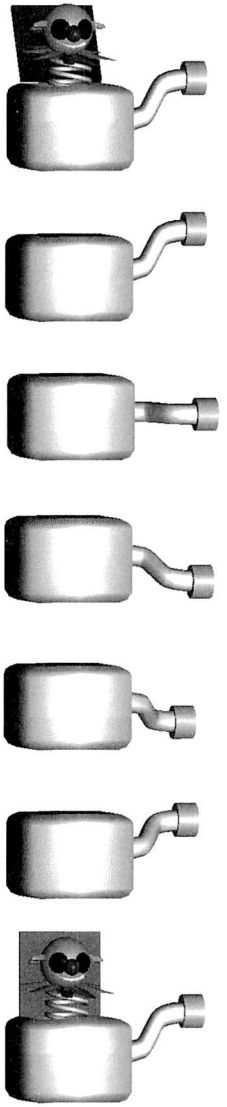
7 **Select Object's X Axis.**
This specifies the axis around which you want the crank to rotate.

8 **Choose OK.**
The rotation animation is now complete.

The animation you've specified turns the crank three times between the time the lid closes and the time it opens again.

To view the animation:

- Using the animation controls, press rewind, then press play. If you are previewing the animation in bounding box render style, you will see only the rotation of the handle's bounding box. Read the next section to learn how to change this option.

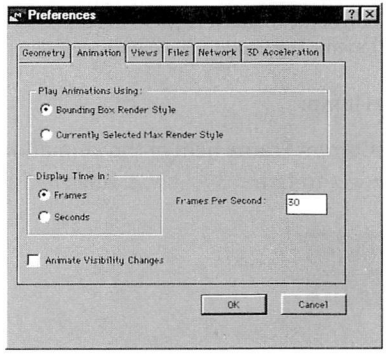


Changing the animation display

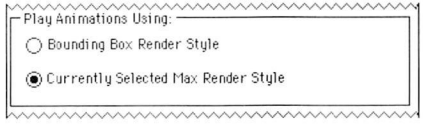
So far when you've played the jack-in-the-box animation, you've seen only the model's bounding boxes move. To view the object's full motion, you can change an option in the Preferences dialog box.

To change the animation display:

1 **Choose Preferences from the Edit menu.**
The Preferences dialog box opens.



2 **On the Animation page, choose Currently Selected Max Render Style.**
This option refers to the Render Style setting in the Window Setup dialog box.



3 **Choose OK.**
Now when you rewind and play the animation, Extreme 3D shows the model's animated movement in the window's render style, rather than in bounding boxes.

Note: Because this setting requires all objects to redraw between frames, Extreme 3D plays the animation more slowly.

Making the model jump

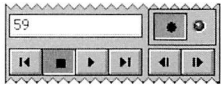
The last effect you'll animate is making the jack-in-the-box model jump up when the lid opens.

You already know that the lid begins opening again at frame 59 and that the animated sequence ends at frame 68. The midpoint of that section is frame 63. That is the frame at which you want the model to reach the highest point of its jump.

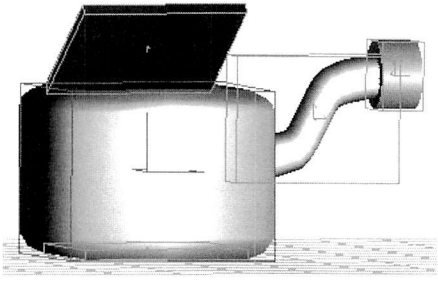
Tip: To easily see the position of the model relative to the ground, you can choose Show Ground Plane from the Object menu. The Ground Plane is displayed in the following figures.

To make the model jump:

1 **Type 59 in the Current Frame field of the animation controls, then press Enter.**
Extreme 3D moves to frame 59—the frame at which the jump should begin.

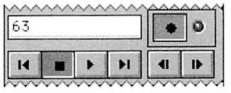


2 **Using the arrow tool, select the jack-in-the-box by dragging a marquee around the entire model.**



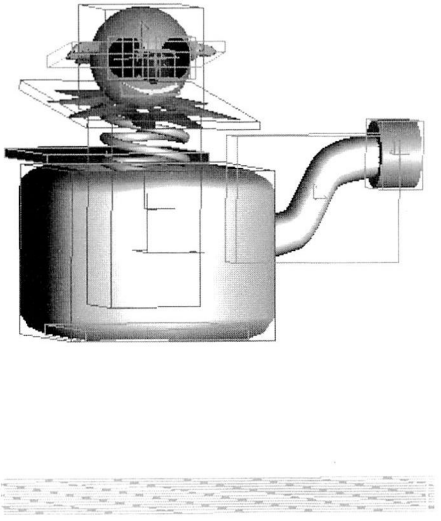
3 **Press the Down arrow key to nudge the model slightly downward.**
This sets the position for the beginning of the jump. If you don't set this position, Extreme 3D assumes you want the jump to begin at the beginning of the entire animation—frame 0.

4 **Type 63 in the Current Frame field of the animation controls, then press Enter.**
Extreme 3D moves to frame 63.

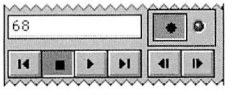


5 **Using the arrow tool select the jack-in-the-box, including the head, collar, and spring that are now shown, by dragging a marquee around the entire model.**

6 **Hold down the V key (to constrain the model's movement along the working plane's vertical axis) and drag the model up in the workspace.**



7 **Now type 68 in the current frame field of the animation controls, then press Enter.**
Extreme 3D moves to the last frame in the animation.



8 **Click once in the window to make the workspace active and select the model again.**

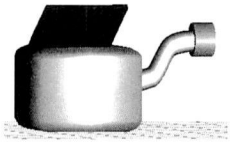
9 **With the model still selected, hold down the V key and drag the model down to approximately the same position that you moved it to in Step 3.**

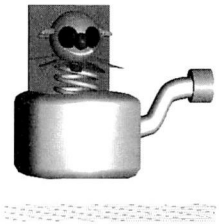
This completes the animation of the jack-in-the-box's movement.

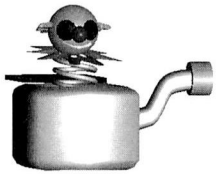
To view this portion of the animation:

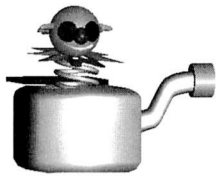
1 **Type 58 in the Current Frame Field of the animation controls, then press Enter.**
Extreme 3D rewinds the animation to the frame just before the jump.

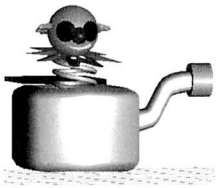
2 **Using the animation controls, press Play.**
You'll see the model jump as the lid opens.











To learn more...

You've now completed the animated sequence for the jack-in-the-box model. It's a good idea to save your work.

- Choose Save As from the File menu and save this version of the jack-in-the-box as Jbox3.E3D.

For more information about animation, see Chapter Four, "Animating."

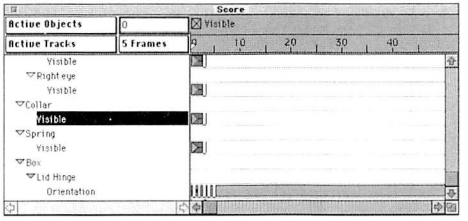
More on creating animation

The animation chapter discusses sophisticated animation techniques and introduces you to the Extreme 3D Score. The score is the tool Extreme 3D uses to keep track of all the animated effects occurring in a sequence.

The animation effects you've created in this section are visible in the Score.

To view the Score:

- Choose Score from the Animate menu.



You can see that everything you've done is recorded on tracks. Each component of the model has its own track and changes to it are visible in the Score.

Another topic discussed in the animation chapter is the camera. You can use Extreme 3D's camera to define a custom view of an animation. You can even animate the camera itself, changing its position as it "films" the scene. Then you can view the animation from the camera's eye.

More on saving animation

After you've created an animated sequence, you can save it as a movie. When you create a movie, Extreme 3D renders each frame in sequence to a file.

You'll save the jack-in-the-box animation as a movie in the last section of this tutorial.

Adding lights

In this section you'll see how to create an overall effect on the jack-in-the-box scene by adding and customizing lights.

You'll learn how to:

- Add a background color to better see lighting effects
- Change the properties of the default light to dim the scene
- Render the effect onscreen
- Add a spotlight to shine on the jack-in-the-box model

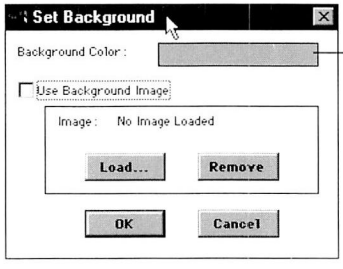
If you haven't already done so, now is a good time to watch "Lighting," one of the *Learning Extreme 3D* movies. View the movie from the Learning Viewer, which can be found on your application CD.

Adding a background color

The model you've been working with so far is shown on a white background. To better see the lighting effects you'll create in this section, first change the background color to a darker shade. Continue working with the model you saved at the end of the previous section.

To change the background color:

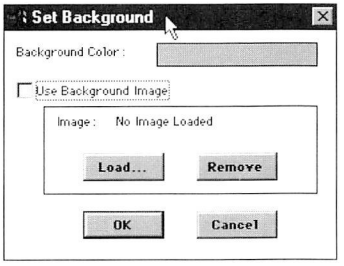
1 **Choose Set Background from the Render menu.**
Extreme 3D opens the Set Background dialog box.



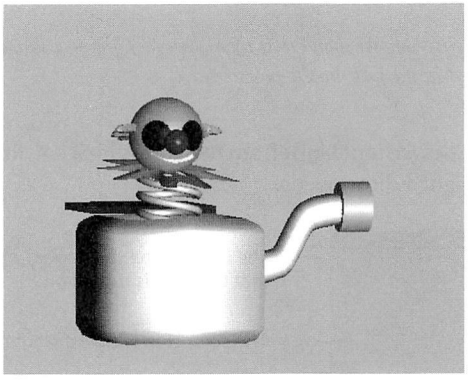
This color chip shows the current background color.

2 **Click the color chip to open the System Color Picker dialog box.**

3 **Choose a pale blue color, then press OK.**
The color you chose is shown in the Set Background dialog box.



4 **In the Set Background dialog box, choose OK.**
The background of the jack-in-the-box model changes to the new color.



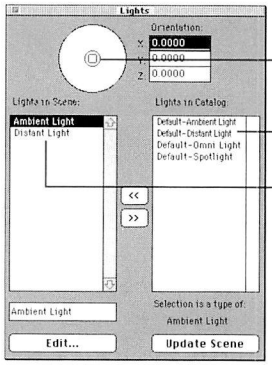
Changing the default Distant Light

Extreme 3D includes two default lights in every file, named Distant Light and Ambient Light. You can't delete the default Distant Light, but you can turn it off or change its properties. Because you'll be adding a spotlight to shine on the model in the next exercise, first you need to dim the default Distant Light.

Note: Before making changes, make sure you're at the beginning of the animation. Open the animation controls and make sure the Current Frame Field is set to 0. Then close the animation controls.

To dim the default light:

1 **Choose Lights from the Window menu.**
Extreme 3D opens the Lights browser.



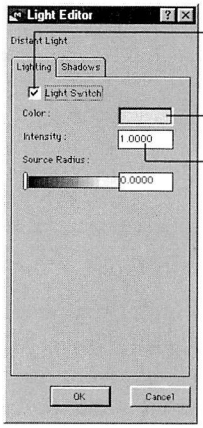
The light pointer shows the default light's position and orientation.

This list shows the types of lights available.

This list shows the lights in the scene you're working with.

The Lights browser shows that there are two lights—a distant light and an ambient light—included in the jack-in-the-box scene.

2 **Select the Distant Light from the Lights in Scene list and click Edit.**
The Light Editor opens.



The Light Switch is checked, showing that the light is turned on.

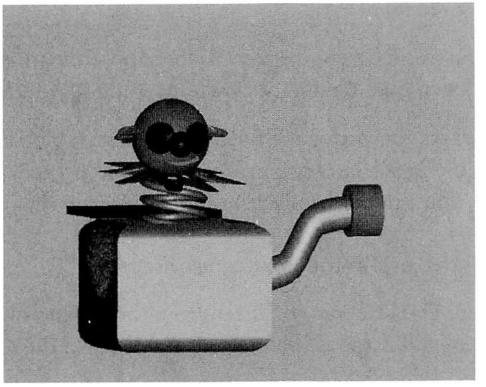
The color chip shows the light's color.

The light's intensity, or strength, can be edited.

3 **In the Intensity text field, type 0.5 to dim the light's intensity by half.**

4 **Choose OK to close the Light editor.**

5 **In the Lights browser, choose Update Scene.**
The jack-in-the-box scene changes to show that the light is dimmed.



6 **Close the Lights browser.**

Rendering the effect onscreen

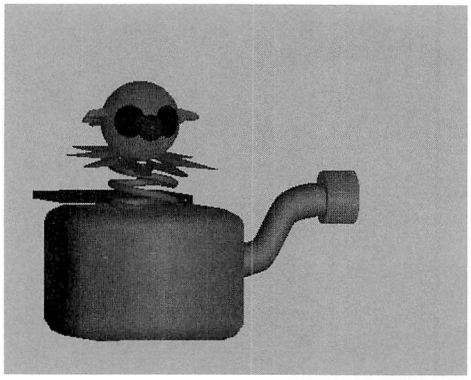
When you chose Update Scene from the Lights browser, Extreme 3D refreshed the onscreen image of the jack-in-the-box using the interactive renderer. Until now, everything you've viewed onscreen has been the product of the interactive renderer.

The interactive renderer displays a close approximation of what you'll see when you perform a final render, but without some subtle effects and details.

Usually when you perform a final render you output a file. You'll output a rendered file in the last section. Until then, to preview what a final render will look like, you can perform a temporary onscreen final render.

To render the jack-in-the-box scene onscreen:

- Choose Final Render to Screen from the Render menu. The status bar shows a progress indicator as the image is rendered in the workspace.



When the render is complete, you see the true lighting and colors of the scene.

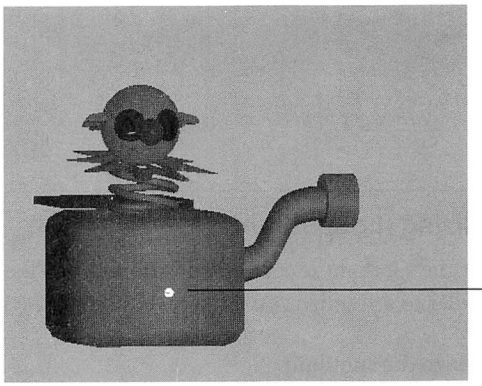
Adding a spotlight

The next effect you'll create is adding a spotlight to shine on the jack-in-the-box model.

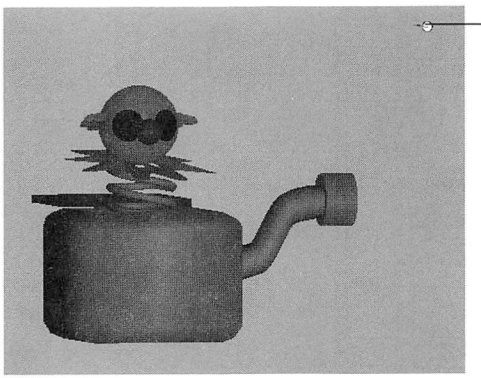
To add a spotlight:

1 **Choose Lights from the Window menu.**
Extreme 3D opens the Lights browser.

2 **In the Lights in Catalog list, double-click Default-Spotlight.**
The default spotlight appears in the Lights in Scene list of the Lights browser, and a spotlight object appears in the jack-in-the-box scene.

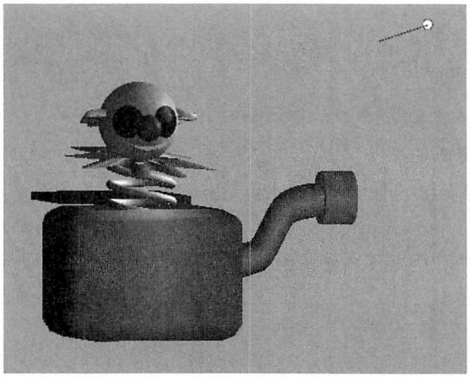


3 **Drag the spotlight in the workspace to reposition it.**



Tip: If you have trouble moving the spotlight object, you can hide the jack-in-the-box, move the spotlight, then show the jack-in-the-box again.

4 **Select the watch link tool from the tool palette, then drag a link from the spotlight to the box.**
This will cause the light to automatically point at the box.



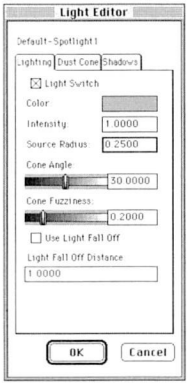
You can see the light from the spotlight shining on the model.

Customizing the spotlight

Now that the spotlight is correctly positioned, you'll create the effect of a cone of light, similar to a spotlight on a stage, shining on the model.

To customize the spotlight:

1 **Select the spotlight from the Lights in Scene list and choose Edit to open the Light editor.**



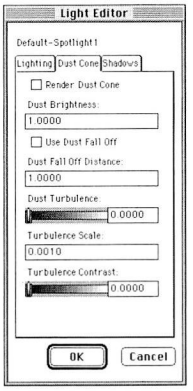
A spotlight has more properties than the default light. Different types of properties appear on different pages.

2 **On the Lighting page of the Light Editor, click the color chip and, using the System Color Picker dialog box, set the spotlight's color to white.**

3 **In the Intensity text field, type 1.5.**

4 **Move the Cone Angle slider to the right to change the value to 40.000.**

5 **Click the Dust Cone page to see the spotlight's dust cone properties.**
When you add a dust cone, Extreme 3D creates dust in the spotlight's beam. This gives the light something to shine on, making the beam visible.



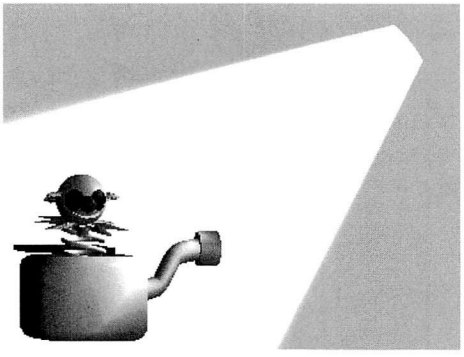
6 **Check the Render Dust Cone check box to turn on dust cones, then change the Dust Brightness value to 0.25.**
Dust Brightness specifies the intensity of dust to create. The value of 0.25 creates fairly dense dust, making the spotlight's beam visible.

7 **On the Shadows page, check the Cast Shadows check box.**

8 **Choose OK to accept the changes you've made and return to the Lights browser.**

9 **Choose Update Scene to view the changes in the jack-in-the-box scene.**
Dust effects are not visible in the interactive renderer, so you won't see the cone until you perform a final render to screen.

10 **Choose Final Render to Screen from the Render menu.**



The spotlight shines on the jack-in-the-box. You can see the light beam because of the dust you created for the light to shine through.

Note: If you don't see the dust cone you created, make sure you're not using the Orthographic perspective setting. Choose Perspective from the View menu, then choose any setting other than Orthographic.

Saving your work

You've now completed the lighting effects for the jack-in-the-box model. It's a good idea to close the Lights browser and save your work.

- Choose Save As from the File menu and save this version of the jack-in-the-box as Jbox4.E3D.

To learn more...

You can create an enormous variety of effects using lights in Extreme 3D. For example, you can simulate the appearance of a natural sunlight, theatrical lighting, or atmospheric fog.

To learn more about creating lighting effects, see Chapter Five, "Lighting and Materials." Additionally, the application CD includes sample images that you can see in the Gallery Viewer, and a Lighting Lab that you can explore from the Learning Viewer. These resources can give you ideas for using lights in your Extreme 3D scenes.

Applying materials

Earlier in this tutorial, you modeled the jack-in-the-box crank. Extreme 3D created the crank using the default material—gray plastic. You've probably noticed that other parts of the model have different colors and appearances. This is because they had different materials applied to them to change their default appearance.

In this section, you'll work with materials. You will:

- Use tool palette tools to apply the material of the lid to the knob
- Create and save a new material in the Materials browser
- Apply a material from the Materials browser
- Apply and position a texture map

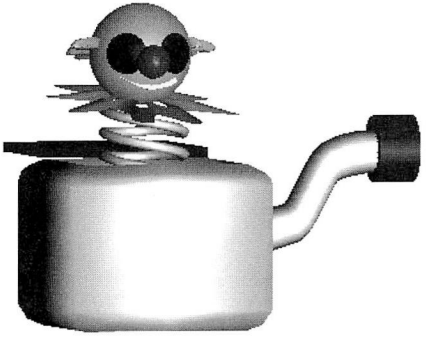
Applying a material with the tool palette

You can copy any material that already exists in a scene to any other object in that scene.

To apply the lid's material to the knob:

1 **Select the eye dropper tool from the tool palette, then click the jack-in-the-box lid.**
The eye dropper tool is located in the materials application tool group, under the bucket tool. When you click an object with the eye dropper tool, the tool picks up the object's material.

2 **Select the bucket tool, then click the crank's knob.**
When you click an object with the bucket tool, the tool applies the currently selected material to the object.



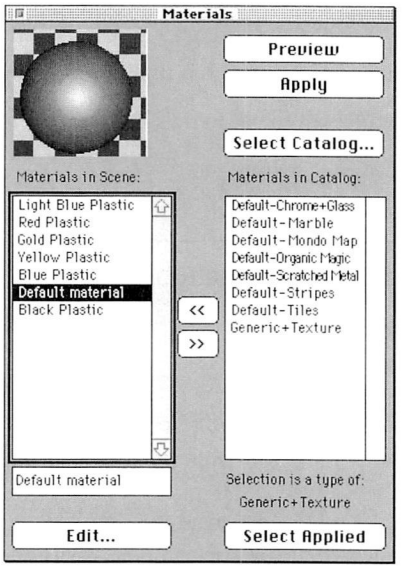
The lid's material (blue plastic) is applied to the crank's knob.

Creating a new material

Extreme 3D includes a set of default materials that you can customize to create other materials.

To create a new material for the crank's handle:

1 **Choose Materials from the Window menu to open the Materials browser.**

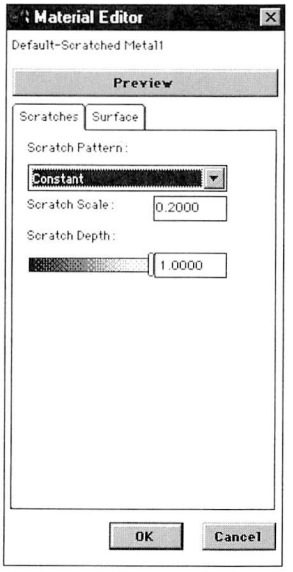


The Materials browser is similar to the Lights browser you used in the previous section.

2 **In the Materials in Catalog list, double-click Default-Scratched Metal.**
The material moves to the Materials in Scene list and remains selected. The preview window updates to show the new material.

3 **With Default-Scratched Metal selected in the Materials in Scene list, choose Edit.**

Extreme 3D opens the Material editor.



4 **On the Scratches page, choose Engine Turning from the Scratch Pattern pop-up.**

5 **Click Preview to see a preview of the material in the Material editor preview window.**

6 **In the Material editor, click the Surface page, then click the color chip and, from the System Color Picker dialog box, choose a shade of gray.**

7 **Click Preview to see a preview of the material. If you like the look, click OK. If not, continue adjusting values until you like the material.**

When you click OK, Extreme 3D saves the values you entered, closes the Material editor, and returns to the Materials browser.

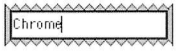
Saving the new material

Now that you've created the material you want, you can name it and save it in the Materials browser.

When Default-Scratched Metal is selected in the Materials in Scene list, it also appears in the text entry field at the bottom of the list.

To name the new material:

1 **Select Default-Scratched Metal and type Chrome in the text entry field at the bottom of the list.**



2 **Press Enter to accept the new name. Default-Scratched Metal is replaced with Chrome in the Materials in Scene list.**

Applying a material from the Materials browser

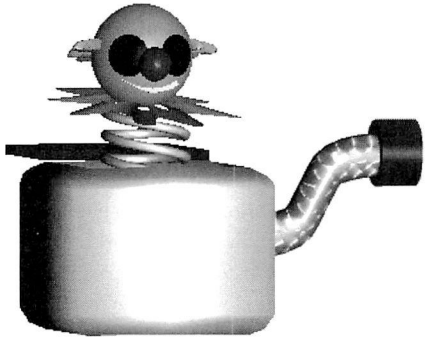
You've created and saved a custom material. Now you can apply that material to the handle's crank.

To apply the new material:

1 **Select the crank in the workspace.**

2 **Open the Materials browser if it is not already open.**

3 **Select Chrome from the Materials in Scene list of the Materials browser, then click Apply.**
Extreme 3D applies the Chrome material to the handle.



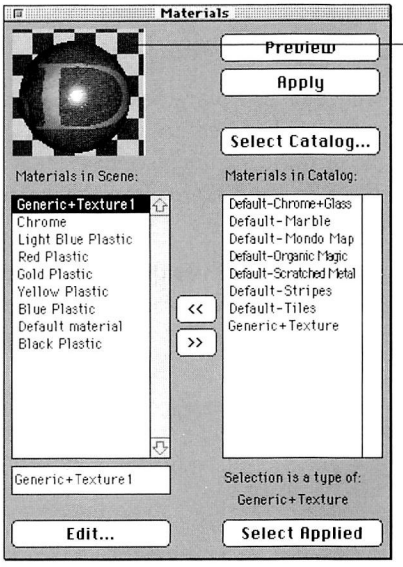
Note: You might need to perform a final render to screen before you see the effect of the material in the workspace.

Using a texture map

In addition to materials, you can use Extreme 3D to apply texture maps to objects. When you apply a texture map, it's as though you wrap an image around an object.

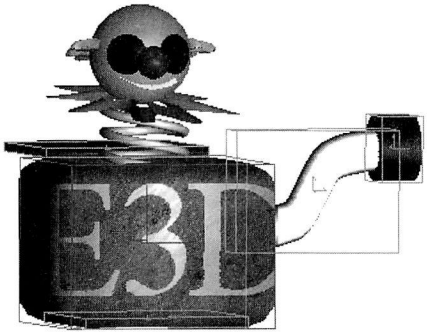
To apply a texture map to the box:

1. **Select the box in the workspace.**
2. **Open the Materials browser if it is not already open.**
3. **Double-click Generic+Texture in the Materials in Catalog list.**
   Extreme 3D copies the default material to the Materials in Scene list.
4. **Click Edit to open the Material Editor, go to the Texture page, and click the Use Texture Map check box, then click OK.**
   This tells Extreme 3D to apply the texture map to the surface of the object.



The texture map appears in the preview window.

5 **Press the Apply button in the Materials browser.**
Extreme 3D applies the texture map to the box.



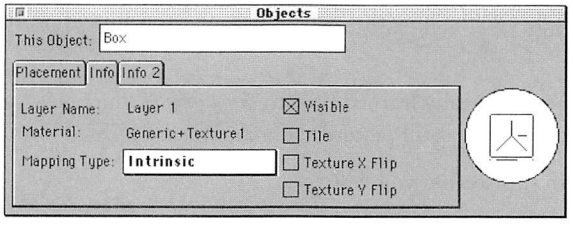
By default, the texture map covers the box completely. You can use tool palette tools to customize the placement of the texture map on the object.

To position the placement of the texture map:

1 **Select the projective texture placement tool.**
The projective texture placement tool is located in the texture placement tool group, under the intrinsic texture placement tool. The projective texture placement tool tells Extreme 3D to project the texture map onto the front and through to the back of the box.

2 **Click and drag to position and size the texture map.**
Press F2 (Windows) or Control (Macintosh) while dragging to increase or decrease the size of the texture map. You'll see the texture map's bounding box as you drag.

3 **Choose Objects from the Window menu to open the Objects browser, then click the Info page.**



4 **Choose Cubic from the Mapping Type pop-up.**
This choice tells Extreme 3D to repeat the texture map on all sides of the box.

This figure shows the jack-in-the-box model after it has been rendered to the screen.

To learn more...

To learn more about creating and applying materials and texture maps, see Chapter Five, "Lighting and Materials." Also, a wide variety of texture map catalogs are included on your application CD in the Wraptures™ folder.

Additionally, the application CD includes sample images that you can see in the Gallery Viewer, and a Materials Lab that you can explore from the Learning Viewer. These resources can give you ideas for using materials in your Extreme 3D scenes.

Rendering

You've now finished creating the jack-in-the-box scene. The model, materials, and lights define how the scene looks, and the animation tracks define how it behaves over time.

You've already learned how to save an E3D file; now you'll learn how to output that file as a still picture and an animated movie.

In this section you will:

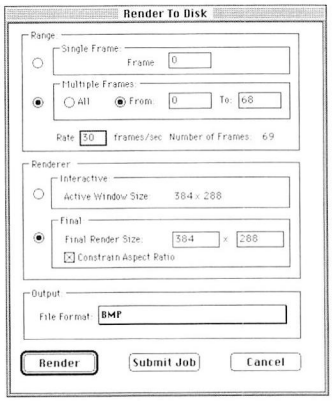
- Output a still image of a single frame
- Output an animated file

Rendering a single frame

When you perform a final render to screen, as you did in the previous section, you can choose any frame of your animated sequence. The same is true for rendering to an external file. You simply choose the frame and the file format you want.

To render a frame of the jack-in-the-box model to a file:

1 **Choose Render to Disk from the Render menu.**
Extreme 3D opens the Render To Disk dialog box.



2 **Choose Single Frame in the Range area of the dialog box and type 2 in the Frame text field.**
This tells Extreme 3D that you want to render a single image, rather than an animated sequence, and specifies frame 2 as the frame you want to render as an external file.

3 **In the Output area of the Render to Disk dialog box, choose BMP as the File Format.**
To learn more about output file formats, see the Render to Disk topic in the Extreme 3D Help system.

4 **Choose Render.**
Extreme 3D opens a system dialog box so you can specify the directory location and file name for the output file.

5 **Choose a directory location and file name for the rendered image file, then choose Save.**

6 **When the BMP Options dialog box appears, select 24-Bit and click OK.**
A progress indicator appears in the status bar, and Extreme 3D displays a message that tells you the rendering is complete when the output file has been created.

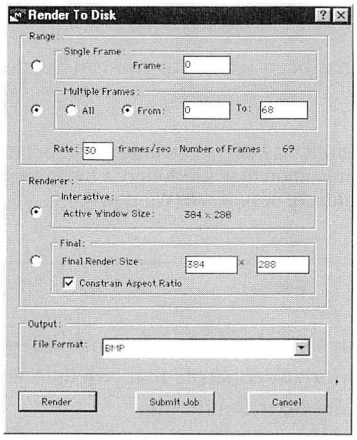
Once you've created the file, you can use the paint or draw program of your choice to view it.

Rendering an animation

Rendering an animation isn't that different from rendering a single frame, except that it takes more time to render multiple frames.

To render the full jack-in-the-box animation:

1 **Choose Render To Disk from the Render menu.**



2 **In the Render To Disk dialog box, choose Multiple Frames in the Range area of the dialog box.**

3 **In the Multiple Frames panel, choose All.**
Extreme 3D automatically fills in the text fields, to show that frames 0 to 68 will be rendered.

4 **In the Output area of the Render to Disk dialog box, choose the file format you want.**
The available file formats depend on whether you're using Extreme 3D on a Macintosh or in Windows. If you are using a Macintosh, choose QuickTime; in Windows, choose AVI (Video for Windows).

5 **Choose Render.**
Extreme 3D opens a system dialog box so you can specify the directory location and file name for the output file.

6 **Choose a directory location and file name for the rendered animation, then choose OK or Save.**
The Compression Settings dialog box appears.

7 **Specify a compression setting.**

On a Macintosh, choose Animation and Millions of Colors from the Compressor pop-ups.

In Windows, choose Cinepak Codec by Radius from the Compressor pop-up.

8 **Accept the remaining default settings and choose OK.**
A progress indicator appears in the status bar, and the message Rendering Complete appears when the output file has been created.

Once the animation has been rendered, you can open it and play it using the player of your choice.

Note: Depending on your system, it may take some time for the animation to fully render. If you prefer, you can play the animation that is included in the Examples folder. This animation is named Jbox Movie (Macintosh) or Jbox.AVI (Windows).

To learn more...

Rendering files can involve a lot of decision making—especially when you render animated movies. Important concepts that will help you make the right decision are discussed in Chapter Six, "Rendering."

Chapter Two
Navigating the workspace

This chapter identifies all the major components of the Extreme 3D working environment and explains the concepts you should know before beginning an Extreme 3D project. Read this chapter if you are new to 3D modeling and animation.

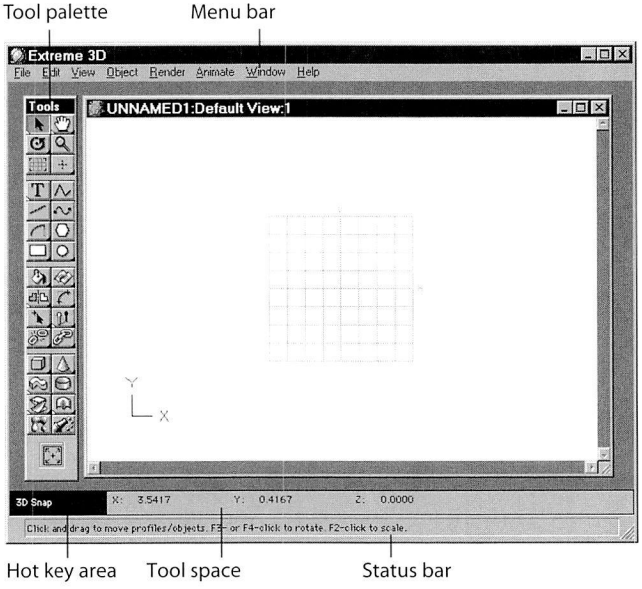
Before you begin working with Extreme 3D, it's a good idea to watch the *Learning Extreme 3D* movies. You can view these movies using the Learning Viewer in the Learning folder on the application CD.

The sections in this chapter introduce:

- The Extreme 3D working environment, including:
  - The tool palette, tool space, and status bar
  - What's in the Extreme 3D world
- Orienting yourself in 3D space, including:
  - Using the three orientation aids: ground plane, orientation axis, and object axis
  - Using the working plane
- Looking around in 3D space
- Finding and organizing the elements of a scene
- Setting up your working environment

The working environment

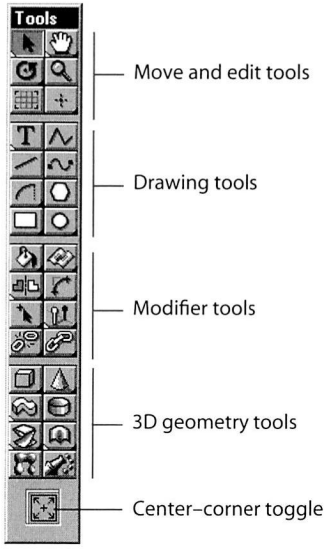
The tool palette, the tool space, the menu bar, and the status bar are the fundamental pieces you use to begin creating objects in the Extreme 3D *world*, the three-dimensional space where you build and manipulate objects.



- The *tool palette* contains tools for creating, modeling, editing, and manipulating objects.
- The *tool space* displays numerical text and measurement information. When creating profiles and surfaces, you can edit these values. The left corner of the tool space—*hot key area*—provides feedback about the current snapping option.
- The *menu bar* contains editing, viewing, object manipulation, animation, rendering, and file and window management commands.
- The *status bar* provides information about using Extreme 3D tools and commands.

Using the tool palette

The tool palette contains tools for modifying views, selecting objects, creating 2D and 3D geometry, and modifying geometry. It can be dragged to any location on your screen, but it cannot be closed.



The arrow tool is the ***default tool.*** When you finish using any other tool, the default tool automatically becomes the selected tool. If you use a tool different from the arrow tool repeatedly, you might want to make it the default tool.

To make any other tool the default tool:

- Press F3 (Windows) or Option (Macintosh) while selecting the tool. Tools with a black notch in the lower right corner indicate a group of tools that perform related functions.

To open a tool group:

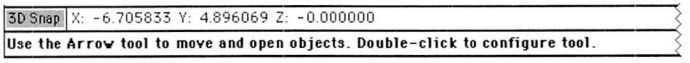
- Press and hold the mouse button while selecting a tool with a black notch. Tools with a white notch in the lower left hand corner indicate that you can set preferences for that tool.

To set a tool's preferences:

- Double-click any tool that has a white notch. For complete information on specific tools and their use, see the Reference section of the Extreme 3D Help system.

Using the tool space

The tool space displays information about whatever tool you're using. When the arrow tool is active, the tool space displays the x, y, and z coordinates of the cursor in the workspace. Other tools display information appropriate to their use.



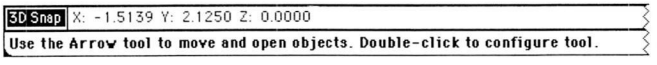
For many of the tools, you can enter information directly into the tool space. The tool space always displays the values specified when you last used the tool. If you haven't used the selected tool during the current session, the tool space displays default values for that tool.

The hot key area of the tool space tells you which snapping option is in effect. Snapping helps you to align objects to points, lines, grids, and other geometry.

For more information, see "Snapping" in Chapter Three.

Using the status bar

The status bar provides context-sensitive help for tools. When the cursor is over a tool in the tool palette, the status bar displays its name. When a tool is selected and the cursor is in the workspace, the status bar tells you how to use the tool. If there are several steps involved in using a tool, the status bar displays each step in succession as you complete the steps.



To toggle the status bar on or off:

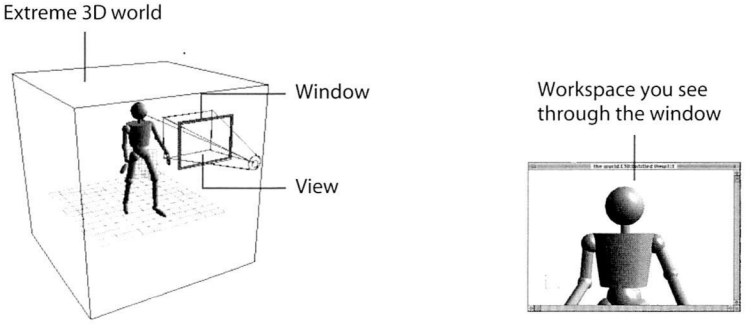
- Choose Show Status Bar from the Window menu.

Using the menu bar

Some of the menu items on the menu bar, such as File, Edit, and Window, contain standard application commands, or commands that are most useful for organizing and managing objects. The other items on the menu bar are arranged by the phase of Extreme 3D production to which they apply. The View menu commands, for example, are useful during the setup phase of production when you are modeling objects or when you are positioning them for animation. The Object menu contains commands that assist you mainly during the modeling and editing of objects. The commands on the Animate menu apply primarily to the animation phase of production. The Render menu commands relate mainly to the final process of creating images with lights and materials applied to your objects. For more information about each menu, see the Reference section in the Extreme 3D Help system.

What's in the Extreme 3D world?

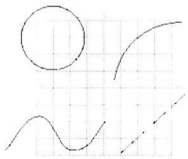
The ***workspace*** is your access into the Extreme 3D world. It is initially framed by the bounds of the untitled ***window*** that appears when you start Extreme 3D. You can change how much of the world the workspace gives you access to by changing the size of the window or by changing the view that is associated with the window.



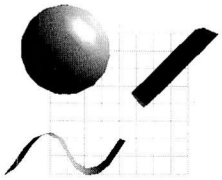
A ***view*** is a means of looking at the world from various distances, positions, and angles. The View menu provides some standard views while the Views browser, available in the Windows menu, lets you create views that are customized to your needs and purposes. Up to ten windows can be open at a time. Each window can be a different size and any window can be associated with any view. Using multiple windows can give you more than one view of the Extreme 3D world at a time.

By adding views, objects, and other elements to the Extreme 3D world you can create a ***scene***, that is, a customized 3D world that you save in a file. ***Profiles*** and ***surfaces***, those objects you create with the tools in the tool palette and add to your scene, are often referred to as ***objects*** or ***geometry***. The profiles that are used to create surfaces are called ***defining geometry***.

Lights and materials are other elements you can add to your scene. Each element of the scene has a relationship to the world and, sometimes, a relationship to other objects in the scene as well. For example, you can link several geometry objects together to create a ***model***. The web of relationships between objects and between scene elements and the world is called a ***hierarchy***. The hierarchical relationship of all the objects that comprise a model is called a ***parent-child relationship***.



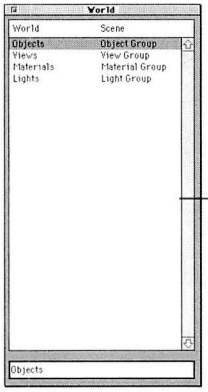
Profile objects



Surface objects

A model made of several surface objects

You can organize all the elements of your Extreme 3D scene using the ***browsers***. Each type of scene element—objects, views, lights, and materials—has a browser associated with it. The World browser is the master browser of Extreme 3D. It displays the hierarchy of the scene including the relationships of objects to each other and the relationship of each element in the scene to the world.

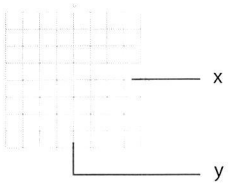


World browser

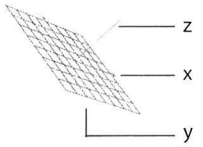
Each of the browsers is discussed in the chapters they apply to, and in the Reference section of the Extreme 3D Help system.

Orienting yourself in the 3D world

In 2D drawing applications, you deal with two dimensions: height and width. When you draw on a graphing grid, these dimensions are represented by the x-axis and y-axis. In three dimensional space, another dimension—depth—is represented by the z-axis. Every point on a three-dimensional object can be defined as coordinates of the x-, y-, and z-axes. In Extreme 3D, all objects, even objects that have only height and width, exist in three-dimensional space.

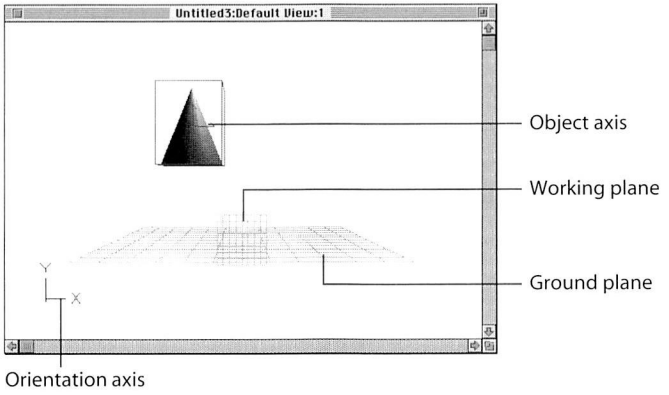


This grid displays two dimensions, x and y.



This grid also displays the z dimension that indicates depth.

Viewing a 3D environment on a two-dimensional computer monitor can be a bit disorienting. As you move through the world and look at your creations from various angles, you can lose track of your original position and forget which way is up. Extreme 3D provides a few mechanisms to help you keep your bearings, all of which can be made invisible in the workspace.



- The *working plane* is the visible portion of an infinite grid that extends throughout the world. When you first start Extreme 3D, the center of the working plane is positioned at the center of the world (0, 0, 0) and it is parallel to the screen. However, you can move the working plane anywhere within the Extreme 3D world.
- The *ground plane* is an unmovable grid that always lies on the x-z plane at the center of the world (0, 0, 0). You can think of the ground plane as the floor or ground in the Extreme 3D world.
- The *heads-up orientation axis* indicates the orientation of the view with respect to the world. The positive directions of each of the world's coordinates are represented by their letter names: x, y, and z.
- Each object can display an *object axis* that indicates that object's orientation relative to the world. The object axis is useful for a number of processes such as determining the object's front and determining its orientation for performing watch links.

Using the working plane

The working plane is the most important of the orientation tools because it functions as more than just a visual reference. Most importantly:

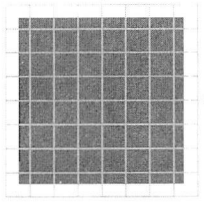
- All drawing is parallel to the working plane.
- All movement is parallel to the working plane.

Since by default all drawing and movement is relative to the working plane, it is best, especially when you are first learning Extreme 3D, to keep the working plane visible. Later you may want to make it invisible.

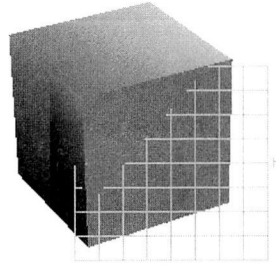
To toggle the display of the working plane off and on:

- Choose Show Working Plane from the Object menu.

Because the working plane is so integral to how you work in Extreme 3D, its default behavior is to always be parallel to the monitor and your view. This is its optimum orientation in order for you to use it as a drawing grid.



Before a view change, both the cube and working plane are parallel to the screen.

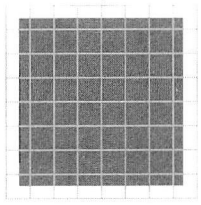


After a view change, the working plane reorients to be parallel to the screen.

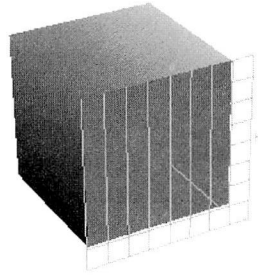
It is sometimes useful to disable this behavior, for example, when you want to use the working plane as visual reference. The Auto Working Plane to View command toggles this behavior on and off.

To change the working plane's default behavior of reorienting to the view whenever it changes:

- Toggle Auto Working Plane to View off by unchecking it on the Object menu.



Before a view change, both the cube and working plane are parallel to the screen.



After a view change, the working plane does not reorient.

Once you get a feel for how the working plane affects the drawing and moving of objects in the world, you can take advantage of several tools and commands that expand the working plane's functionality. For example, you can reorient and reposition the working plane so you can draw or move objects anywhere in the Extreme 3D world. You can also turn off Auto Working Plane to View and lock the working plane in order to change your view but have the working plane maintain its position in the world so you can use it as a visual reference.

Repositioning the working plane

Sometimes you just want to move the working plane to another place on your screen. To do this you can treat the working plane just like any other object and select and move it using the arrow tool. Or you can use the arrow keys to ***nudge*** the working plane—move it in small increments—up, down, right, or left once it is selected.

To move the working plane:

- Select the working plane with the arrow tool and drag it. The working plane moves in the workspace as you drag.

You can also reposition the working plane by assigning it specific coordinates in the Extreme 3D world. This is done using the Objects browser. For information on using the Objects browser, see the Reference section of the Extreme 3D Help system.

Reorienting the working plane

Sometimes you might not want the working plane to be parallel to your screen. You might want to draw on it at an angle. One way to reorient the working plane, regardless of its Auto Working Plane to View status, is to rotate it. As with any other object, you can use the arrow tool with modifier keys to freely rotate the working plane around two axes at a time.

To rotate the working plane:

- Press F3 or F4 (Windows) or Option or Command (Macintosh) while dragging the working plane with the arrow tool. F3 (Windows) or Option (Macintosh) rotates the working plane about the y- and z-axis. F4 (Windows) or Command (Macintosh) rotates the working plane about the x- and z-axis.

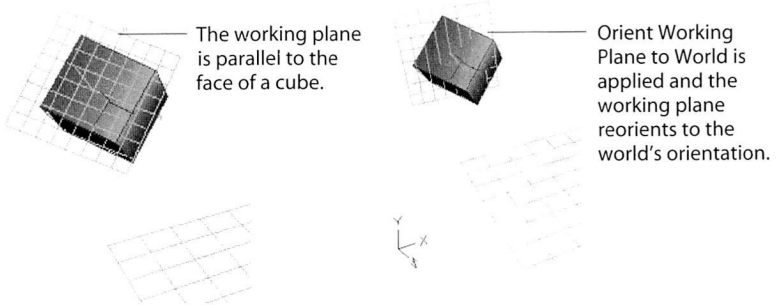
You can also rotate the working plane around a single point using the rotate point tool. Or you can reorient and reposition the working plane to any specific location in the Extreme 3D world by using the working plane tool. For more information about these tools and their use, see Chapter Three, "Modeling," and the Reference section of the Extreme 3D Help system. You can use the Objects browser to reorient the working plane by an exact value. For information about using the Objects browser, see the Reference section of the Extreme 3D Help system.

Some other techniques for reorienting the working plane are most useful for getting the working plane back to a known place in the Extreme 3D world after you have moved it. Because these techniques may change both the orientation and position of the working plane, they require that Auto Working Plane to View be turned off.

To orient the working plane to the world:

1 **Uncheck Auto Working Plane to View from the Object menu.**
Orient Working Plane to World is not available as an option if Auto Working Plane to View is on.

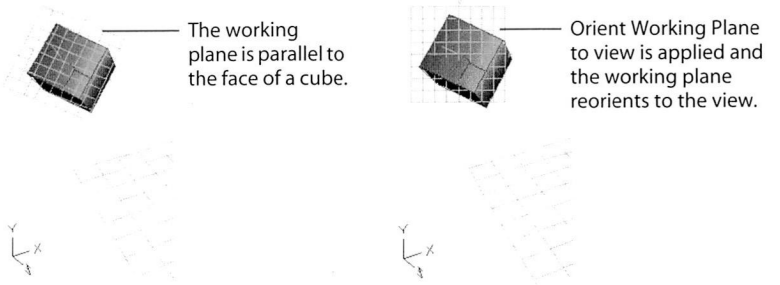
2 **Choose Orient Working Plane from the Object menu, then choose To World.**



To orient the working plane to your view:

1 **Uncheck Auto Working Plane to View from the Object menu.**
Orient Working Plane to View is not available as an option if Auto Working Plane to View is on.

2 **Choose Orient Working Plane from the Object menu, then choose To View.**

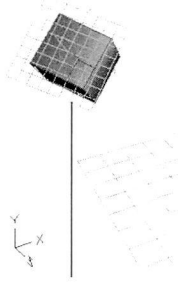


Note: Orient Working Plane to View reorients the working plane to your view only once. Auto Working Plane to View automatically reorients the working plane to the view every time you change your view.

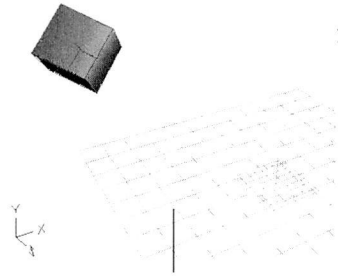
To orient the working plane to the ground:

1 **Uncheck Auto Working Plane to View from the Object menu.**
Orient Working Plane to Ground is not available as an option if Auto Working Plane to View is on.

2 **Choose Orient Working Plane from the Object menu, then choose To Ground.**



The working plane is parallel to the face of a cube.



Orient Working Plane to Ground is applied and the working plane reorients to the ground.

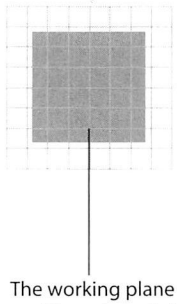
Locking the working plane

For general use, toggling Auto Working Plane to View on and off gives you the most flexibility for using the working plane. Occasionally, however, it is useful to lock the working plane to its current position and orientation in the workspace, especially when you want to use it as a visual reference.

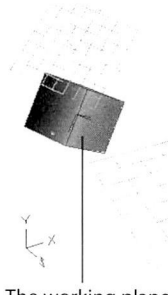
To lock the working plane:

1 **Uncheck Auto Working Plane to View from the Object menu.**
Lock Working Plane is not available as an option if Auto Working Plane to View is on.

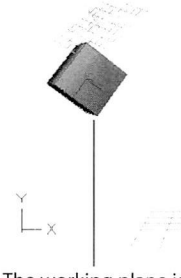
2 **Choose Lock Working Plane from the Object menu.**



The working plane is positioned parallel to the face of the cube.



The working plane is locked and the cube is moved.



The working plane is locked, the cube is moved, and the view is changed.

Using the ground plane, orientation axis, and object axis

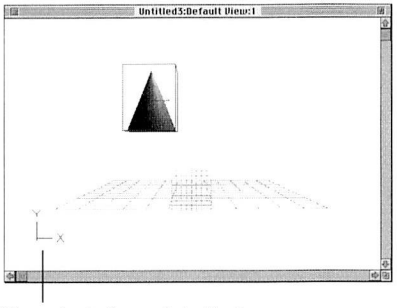
Three other orientation aids, the ground plane, the orientation axis, and an object axis for each object, serve as references and can be turned on when they are useful to you, or turned off when your scene becomes too cluttered.

The ground plane is always at the center of the Extreme 3D world and is parallel to the x-z plane. You cannot select or move the ground plane, but you can turn the display of the ground plane on and off. The ground plane is off by default.

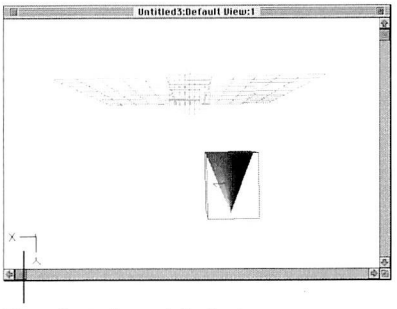
To toggle the display of the ground plane on and off:

- Choose Show Ground Plane from the Object menu.

The heads-up orientation axis is always in the lower left corner of the workspace. The orientation axis always reflects the coordinates of the world. You cannot select or move the orientation axis, but you can turn the display of the orientation axis off and on. The orientation axis is on by default.



The orientation axis indicates you are viewing the world right side up and from the front.



The orientation axis indicates you are viewing the world upside down and backwards.

To turn off the display of the orientation axis:

1. **Choose Preferences from the Edit menu and click the Views page.**
2. **Uncheck the Display Heads-up Orientation Axis check box.**

Each object can display its axis. This axis represents the object's orientation relative to the world. How the axis is oriented within an object depends on what tools and view were used when the object was modeled. The object axis for all objects is on by default. You cannot turn the object axis off for an individual object.

To turn off the display of all object axes:

1 **Choose Preferences from the Edit menu.**
Extreme 3D opens the Preferences dialog box.

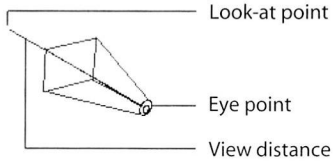
2 **Click the Geometry page.**

3 **Uncheck Display Object Axis.**

Looking around in 3D space

As you create scenes in Extreme 3D, you can move around in the world and look at the scene from various distances and positions, just as you would if you were creating a piece of sculpture. You move around in the Extreme 3D world by changing the view.

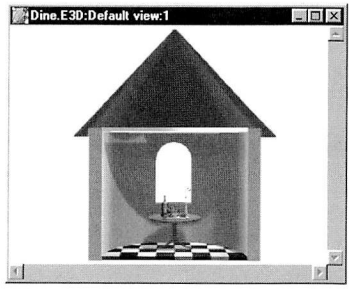
Extreme 3D views have three elements. You can think of the ***eye point*** as your own location relative to the Extreme 3D world. The ***look-at point*** is the center of the view (that is, the point in the world at which the view converges). The ***view distance*** is the distance between the eye point and the look-at point. These three parts of a view maintain a relationship to one another. Together they are used to change the position, orientation, scale, and perspective of the view.



In this section you see how to create and modify views, and how to use the Views browser to manage views. Creating multiple windows and associating different views with each is also covered.

To use the sample file shown in the next few sections:

- Choose Open from the File menu and choose Dine.E3D from the Dine folder, inside the Examples folder.



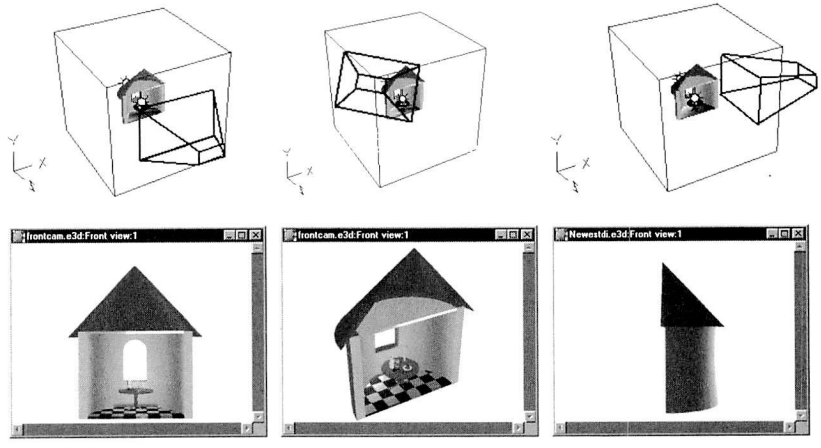
Using preset views

When working in a three-dimensional workspace, you frequently need to view the world from different orientations. Instead of rotating objects and possibly unintentionally changing the positions of the working plane and other objects in the world, you can use the preset views to view the world or objects in them from different angles and perspectives.

Orienting a view to the world

Using the Front, Back, Left, Right, Top, Bottom, Three-Quarters, and Home views available from the View menu, you can quickly change your vantage point of the world, enabling you to see it from different angles. When you choose any of these views your position relative to the world—that is, the eye point of the view—changes, but the look-at point remains at the center of the world.

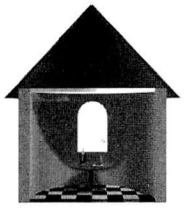
The front view is the default view. Front is the view along the world's z-axis, looking from positive z direction towards negative z. The positive y direction of the world is up.



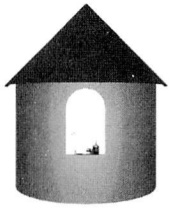
Front *Three-quarters* *Right*

To change the current view to one of the preset views:

- From the View menu, choose an angle from which you want to view the world.



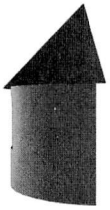
Front



Back

Top

Bottom



Left

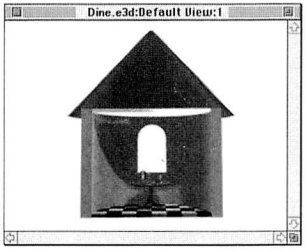
Right

Three-quarters

The Home view returns the view to the default settings. This is especially useful if you've changed views many times and need to reorient yourself in the workspace.

To restore the default view:

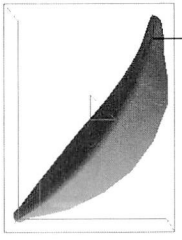
- Choose Home from the View menu. Extreme 3D restores the current view to the default settings.



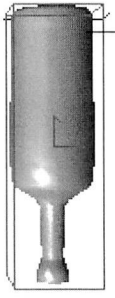
Orienting the view to an object

Sometimes you might want a specific object or model in the world to be the center of the view. The Orient to Object's submenu has several preset views that display the specified side of the selected object in the center of the view.

Which face is front is determined when you create an object. The front is the face of the object that is oriented to the screen when positive y of the object points up and positive x of the object points to the right. Use the object axis as a reference to determine which face is the front face of any object. Depending on the size of the object and where it is in the world, the view may be scaled and your position in relation to the object—the eye point of the view—may change. However, the look-at point is always at the center of the selected object.



Although the banana is lying flat on the table, Orient to Object's Front when the banana is selected results in this view.

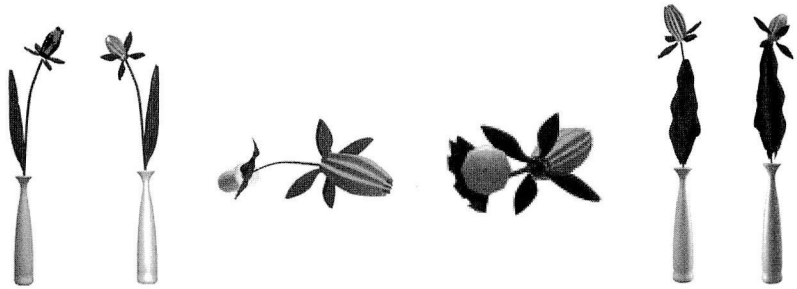


Although the bottle is standing on its base, Orient to Object's Front when the bottle is selected results in this view.

To change the view based on an object's orientation:

1 **Select an object, such as the flower vase in the Dine.E3D scene, to which you want to orient your view.**

2 **Choose Orient to Object's from the View menu, then choose the face of the object you want to view.**



Front *Back* *Top* *Bottom* *Right* *Left*

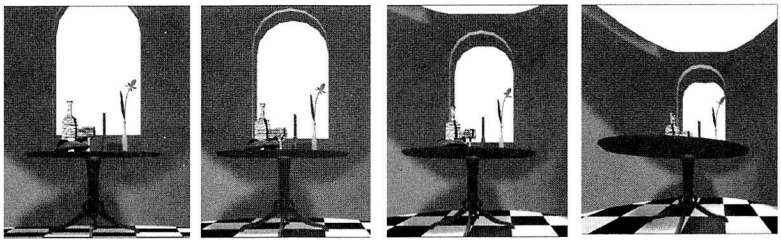
Tip: Selecting an object by name in the World browser and using the object orientation commands simultaneously finds an object in a crowded world and specifies a viewing angle for the object.

Changing view perspective

To more accurately simulate a three-dimensional workspace, Extreme 3D lets you specify the distance from which you view the world. This is known as ***perspective***. In all the perspective options, the size of objects appear to change as your distance from them changes. However, the positions, orientations, and scales of the objects in the world remain unchanged. Only your view distance changes.

To change the view perspective:

- Choose Perspective from the View menu and choose the perspective you want to apply to the current view of the world. Extreme 3D adjusts your view of the world to the selected viewing distance.

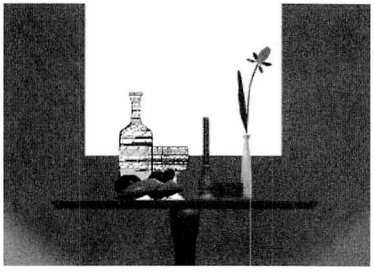


Narrow *Moderate* *Wide* *Very Wide*

In the real world, objects viewed from a distance appear to get smaller the further they are from you. This is regular perspective viewing. When using an orthographic perspective, objects are displayed without any sense of perspective. Instead, they are lined up in the order that they recede from you, and object size is displayed as if each object were the same distance away. It is helpful to use an orthographic perspective for some modeling and snapping procedures.

To use an orthographic perspective:

- Choose Perspective from the View menu, then choose Orthographic.



The Dine.E3D scene in orthographic perspective

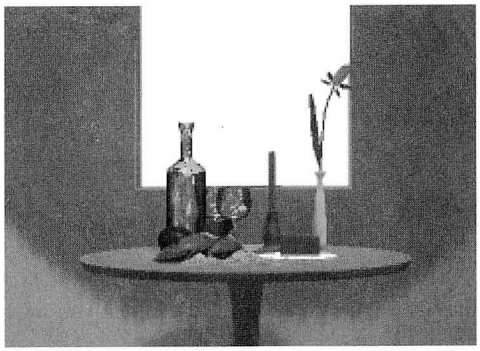
There might be times when the Extreme 3D view perspectives don't give you the effect you want. If so, you can specify a custom perspective. The maximum distance from which you can view the model depends on the current settings in the Units dialog box. For more information, see "Setting up your work environment" on page 133.

To define a custom perspective:

1 **Choose Perspective from the View menu, then choose Custom.**
Extreme 3D displays the Custom Perspective dialog box.

2 **Enter a number in the View Distance field that specifies a distance between the eye point and the look-at point.**

3 **Click OK to apply the perspective to the view.**



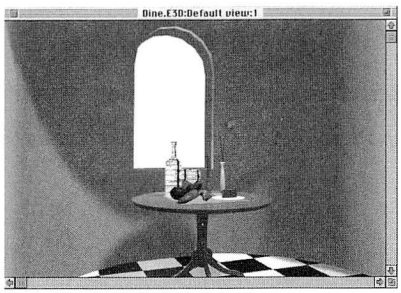
Note: You cannot set a custom perspective to a view distance of less than 0.7 inches or a distance greater than 13.9 inches.

Fitting a view to the window

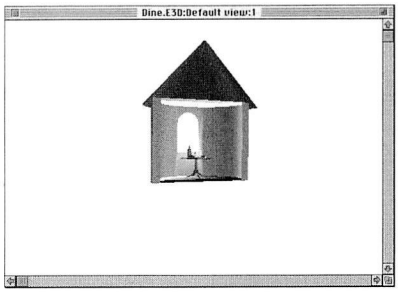
While you are working, it is sometimes possible to lose sight of objects in the world. Fit to Window changes the current view so that all objects that you haven't explicitly hidden in a scene are visible in the window. This feature is also useful for finding objects that you may have moved to distant places in the world.

To fit all the objects in the scene into the current window and view:

- Choose Fit to Window from the View menu.



Before Fit to Window



After Fit to Window

Modifying views

Using preset views, you can quickly change your viewpoint. However, if you want to see the Extreme 3D world from a vantage point different than those offered by the presets, you can modify any view using a number of techniques. This section describes how to:

- Move views
- Scale views
- Rotate views
- Nudge views

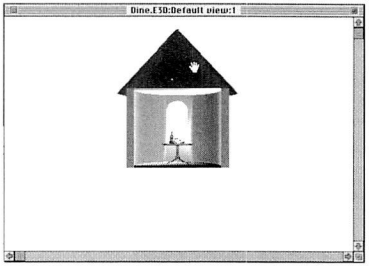
Moving views

The window is the frame through which you view the Extreme 3D world. You can move the view inside the window frame either interactively (using the hand tool) or by value (using the Views browser). When you move the view, it moves parallel to the screen.

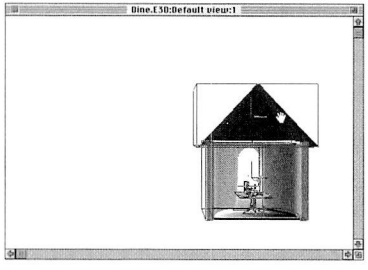
To interactively move the view:

1 **Select the hand tool.**

2 **Drag in the workspace in the desired direction.**
The view changes as you drag. The objects in the scene are displayed in bounding box mode as you change the view. They do not change position; only the view changes.



The view before it is moved

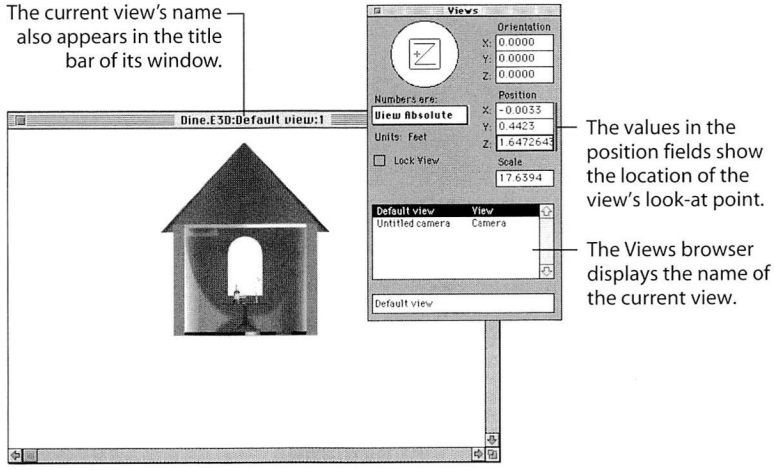


The view after it is moved

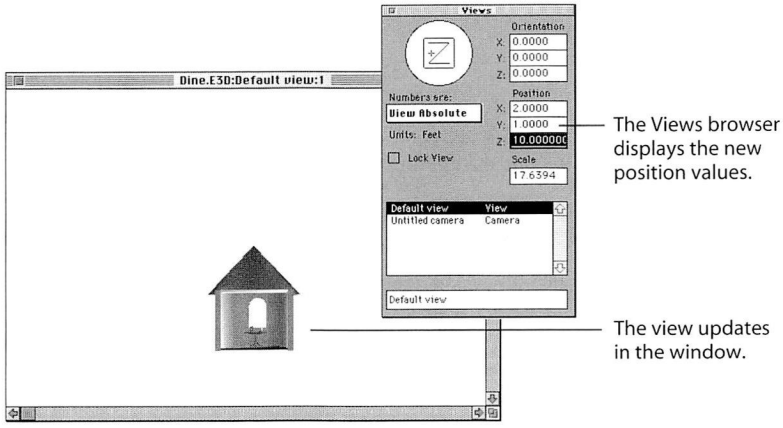
Any time you make changes to the current view, either by using a preset view or by using the view tools, you are modifying its view values. Sometimes you know exactly how much you want to move a view. You can adjust a view's position by value in the Views browser. To reset the view using the exact values that you type in the position fields, choose View Absolute from the Numbers Are pop-up. To reset the view using values that represent a difference from the previous setting, choose Delta to View from the Numbers Are pop-up.

To move a view precisely:

1 **Choose Views from the Window menu.**
The Views browser appears on the screen with the name of the current view highlighted in the views list.



2 **Type new values in the position fields. Press Tab to move between browser fields and accept the new values or press Enter.**

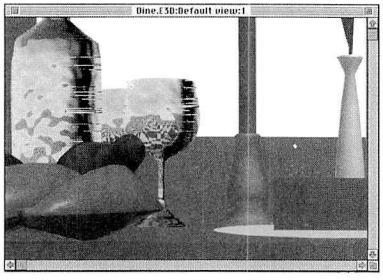


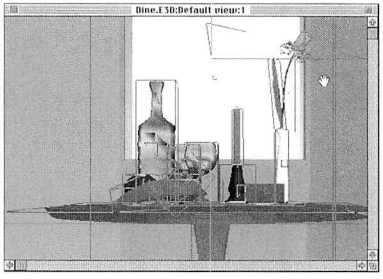
Scaling views

When you scale the view, you see more or less of the Extreme 3D world. You can scale the view interactively, zoom in and out by a specified zoom factor, or scale the view by value.

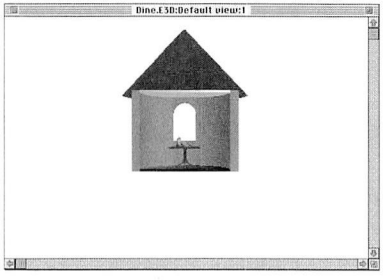
To scale the current view:

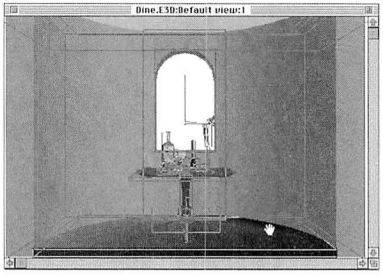
- Press F2 (Windows) or Control (Macintosh) while dragging in the workspace. To see more of the world, drag up in the workspace with the hand tool using a modifier key.





To view a smaller area of the world in more detail, drag down in the workspace with the hand tool using a modifier key.





The hand tool calculates the view scale in world space, or units.

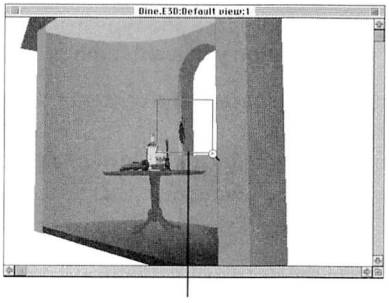
Note: Use the hand tool preference to specify whether you want the view to scale around the look-at point, the eye point, or the center of a selected object. The default setting scales the view around the look-at point.

Another way to scale the view is to zoom. The zoom tool moves the eye point of the view closer to or farther away from objects in the scene. The zoom tool calculates the zoom in screen space, or pixels.

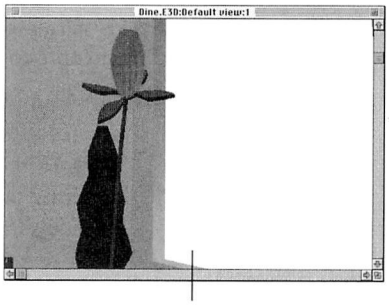
To zoom in on the view:

1 Select the zoom tool.

2 Either drag a marquee in the workspace around the area you want to see more of, or click a point in the workspace to indicate the part of the scene on which you want to zoom in.



A marquee

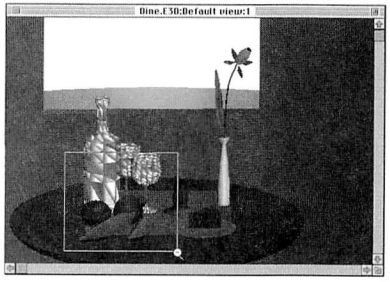


The area that was selected by the marquee

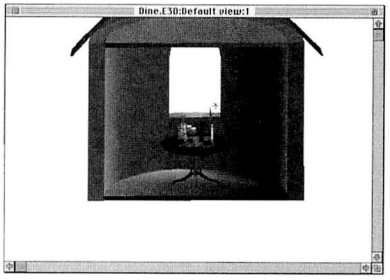
To zoom out of a view:

1 Select the zoom tool.

2 Press F3 (Windows) or Option (Macintosh) while either dragging with the zoom tool or clicking a point in the workspace to indicate the part of the scene from which you want to zoom out.
The zoom pointer shows a - (minus) sign, indicating that you are zooming out of the view.



Before zooming out, the marquee area is not centered.



After zooming out, the marquee area is centered.

By default, the zoom tool zooms by a factor of two. This means you are two times closer to or farther away from the scene when you zoom in or out. You can customize the zoom factor using the tool space.

To zoom by a specific zoom factor using the tool space:

1 **Select the zoom tool.**

2 **Press Tab to enter the tool space and type in a value that defines the exact percentage of magnification you want, then press Enter.**

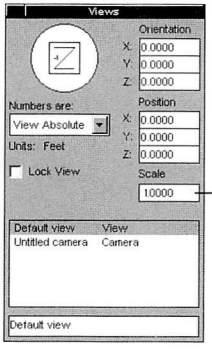
3 **Click a point in the workspace at the center of the portion of the scene on which you want to zoom.**
Extreme 3D magnifies or reduces the current view by the specified percentage, centering the view on the point you click. To zoom out, use the F3 key (Windows) or Option key (Macintosh) as you click in the workspace.

You can also customize the degree of magnification of a view using the Views browser.

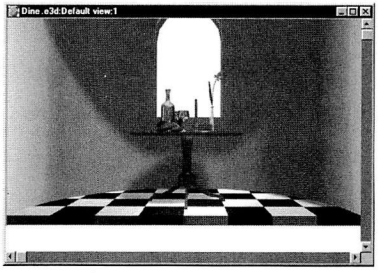
To zoom by a specific zoom factor using the Views browser:

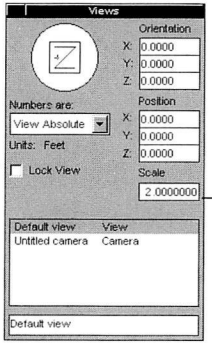
1 **Choose Views from the Window menu.**
The Views browser appears on the screen with the name of the current view highlighted in the views list.

2 **Enter a value in the Scale field and press Enter.**
The scale of a view is represented by a decimal number—1.0 equals 100 percent. A value of 0.5 makes the view larger. A value of 2.0 makes the view smaller.

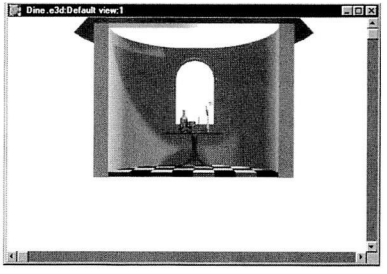


A scale value of 1





A scale value of 2



To return a view to its original scale:

- Enter 1.0 in the Scale field of the Views browser.

Rotating views

You can rotate views around a single axis or around a combination of two axes. When you rotate the view around a pair of axes, you can quickly modify the view in one step rather than two. Rotate around a single axis when you need to precisely control the direction of the rotation.

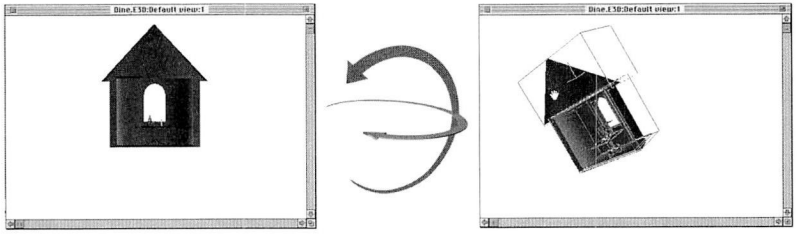
By pressing modifier keys, you can interactively rotate the view around either the y- and z-axes or the x- and y-axes.

To rotate a view around the y- and z-axes:

1 **Select the hand tool.**

2 **Then either:**

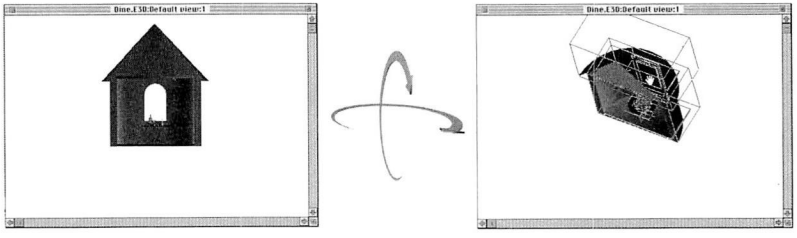
- Press the F3 key (Windows) or Option key (Macintosh) and drag the view in the workspace. The view rotates around the y- and z-axes.



The view before rotation

The same view after rotation around the y- and z-axes

- Or press the F4 key (Windows) or Command key (Macintosh) and drag the view in the workspace. The view rotates around the x- and y-axes.



The view before rotation

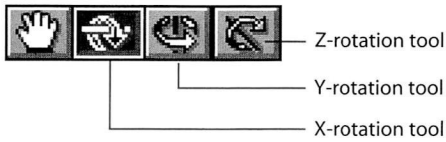
The same view after rotation around the x- and y-axes

Note: By default, views rotate around the look-at point. Use the hand tool preferences to rotate instead around the eye point or around the center of the selected object.

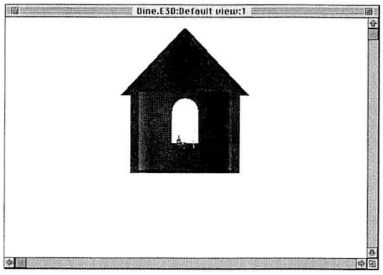
You can rotate the view around a single axis using one of the rotate view tools.

To rotate the view around a single axis:

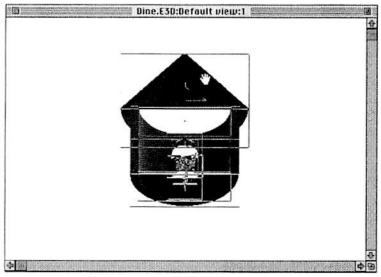
1 **Select a tool from the view tool group.**



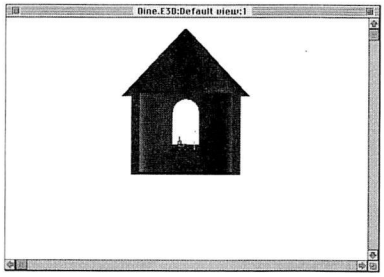
2 **Drag in the workspace to rotate the current view around that axis.**



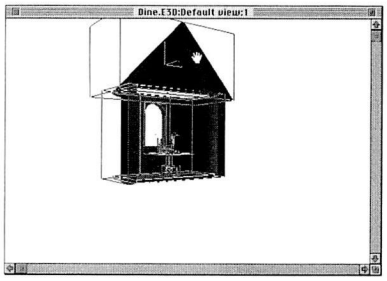
The view before rotation



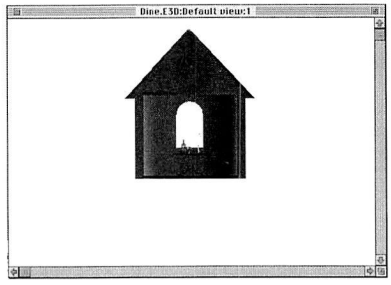
The same view after rotation around the x-axis



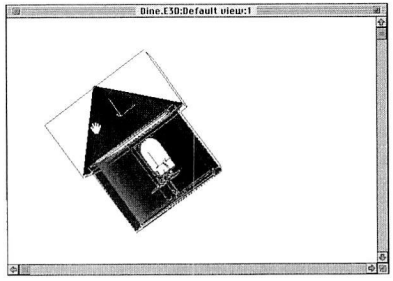
The view before rotation



The same view after rotation around the y-axis



The view before rotation



The same view after rotation around the z-axis

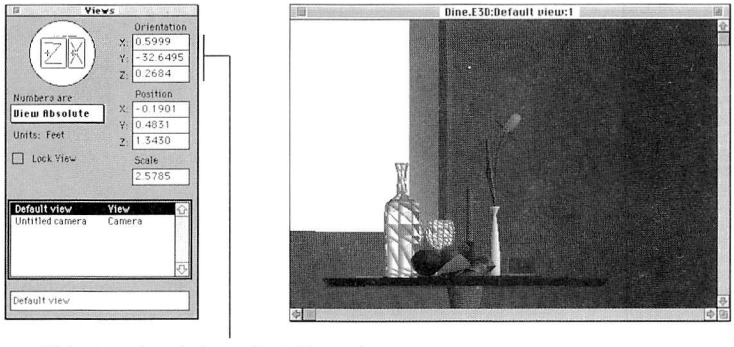
When you want to rotate a view by an exact number of degrees, use the Views browser. The orientation fields in the Views browser indicate how many degrees your eye point is rotated around the look-at point.

To rotate a view an exact number of degrees:

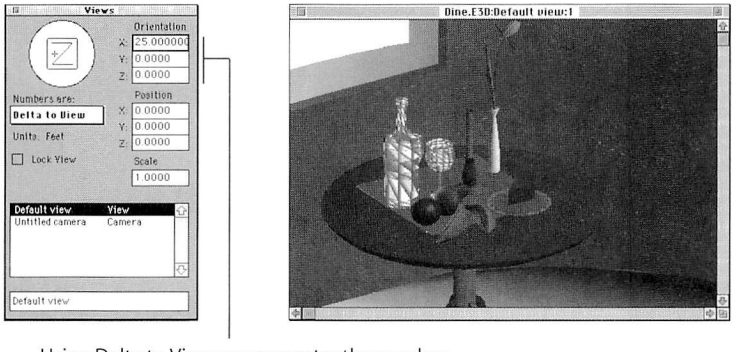
1 **Choose Views from the Window menu.**
The Views browser appears on the screen with the name of the current view highlighted in the views list.

2 **Set the Numbers Are pop-up to Delta to View.**
Delta to View sets the orientation field to zero. This allows you to enter the number of degrees you want to rotate the view, without having to add or subtract that value from the current orientation values.

3 **Type new angle values in the orientation fields. Press Tab to move between browser fields and Enter to accept the new values.**
The workspace changes to reflect the modified view. After the view is changed, Delta to View again resets the field to zero. You can choose View Absolute from the Numbers Are pop-up to see the view's new orientation values.

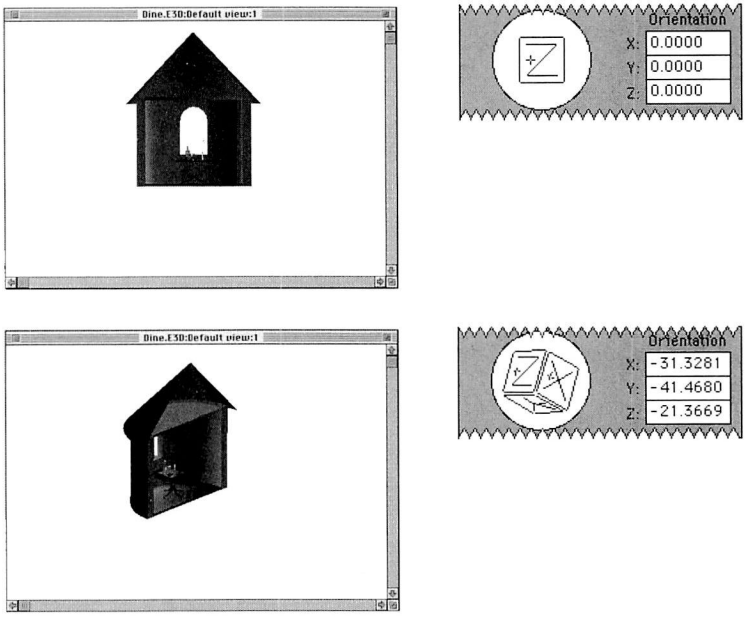


This view already has orientation values.



Using Delta to View you can enter the number of degrees you want the view to rotate.

Another way to change the view orientation is to drag the view ***trackball***—the cube in the Views browser that represents the orientation of the current view. As you drag the trackball, the values displayed in the orientation fields change to indicate the modified view. Extreme 3D updates the workspace in the current window to reflect the changes to the view.



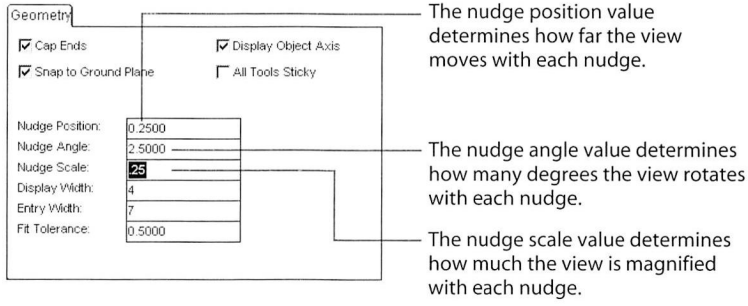
Nudging views

When the hand tool is active, you can nudge your view of the workspace using the arrow keys on your keyboard. Use nudging to move, rotate, or scale a view by small increments.

The amount that the view will move, rotate, or scale is determined by the values in the Preferences dialog box.

To modify these values:

- Choose Preferences from the Edit menu and click the Geometry page.



It can be useful to change the nudge preference values to suit the level of detail at which you are working. You can use the arrow keys with the hand tool by itself to nudge the view position. Or you can use the arrow keys with the arrow tool in combination with the scale and rotation constraint keys to nudge the angle and magnification of the view.

To nudge the view's position choose the hand tool and:

- Press the Up, Down, Left, or Right arrow keys to move the selected view in the direction specified.

To nudge the view's rotation choose the hand tool and:

- Press F3 or F4 (Windows) or Option or Command (Macintosh) while pressing an arrow key to rotate the view in that direction.

To nudge the view's scale:

- Press F2 (Windows) or Control (Macintosh) while pressing an arrow key to scale the view by a small increment.

Note: You cannot perform nudges while any browser is active. Click outside the browser before using the keyboard to nudge.

The following table shows the effects of moving, scaling, zooming, and other actions on view values.

This action:	Changes these view values:			
	Look-at point (position)	Eye point (orientation)	Scale	Perspective
Drag left or right with hand tool	✔			
Drag up or down with hand tool	✔			
Scale with hand tool	Varies*	Varies*		
Rotate with hand tool	Varies*	Varies*		
Zoom in or out with zoom tool			✔	✔
Choose Perspective command				✔
Choose Fit to Window command	✔		✔	✔**
Preset views commands	✔			
Orient to Object command	✔	✔		
Change Position fields in Views browser	✔			
Change Orientation fields in Views browser		✔		
Change Scale fields in Views browser			✔	
Move trackball in Views browser		✔		

* In the hand tool preferences, you can specify if you want views to scale or rotate around the look-at point, the eye point, or the center of a selected object when you use the hand tool.

** If the current view's perspective is moderate, the perspective does not change. If the current view's perspective is anything except moderate, the perspective changes to moderate.

Creating and organizing views

In addition to using the Views browser to display and change the position, orientation, and scale values of the current view, you can use it to create and maintain a catalog of custom views. The Views browser always has at least two views, the default view and the camera view.

This section describes how to:

- Create new views
- Organize views

Creating a new view

By creating custom views, you can return predictably to a vantage point that is useful both to your work style and to the various phases of creating your scene. Once you have a number of views, you can use the Views browser to switch between views.

To create a new view:

1. **Choose Views from the Window menu to open the Views browser.**
2. **Choose New View from the View menu.**
   A new view is created and becomes the current view. It has the same position, orientation, scale, and perspective as the view that was current when the new view was created.

All new views are named "Untitled View." By assigning a descriptive name to a view, you can quickly identify it and choose it from the list of views. You can rename views as many times as you want.

To name a view:

1. **If it is not already the current view, select the view you want to name or rename from the views list of the Views browser.**
   When a view is selected, its name is highlighted in the views list and it appears in the views text entry field.
2. **Type a new name in the views text entry field below the views list and press Enter.**

As you create custom views, their names are added to the views list. You can make any view the current view.

To make a view the current view:

- Click the name of the view in the view list in the Views browser.

You might want to create some views that cannot be changed. Locking a view keeps a view from being changed. If you don't lock a view, and do not switch to a different view, your next action with a hand or zoom tool or your next selection of a preset view will modify the current view.

To lock a view:

- Make the view you want to lock the current view, then check the Lock View check box.

Organizing views

Once you have created a number of custom views, you might want to take advantage of some of the techniques Extreme 3D has for organizing and managing views.

Duplicating views

Duplicating views can be useful throughout your production process. One reason to duplicate a view is to maintain the original view's settings and locked status and still use the settings of that view as a starting point from which to modify your view.

To copy a view:

1. **Choose Views from the Windows menu to open the Views browser.**
2. **Select the name of the view you want to copy from the view list.**
   Extreme 3D changes the view in the current window to the view associated with the selection.
3. **Make a copy of this view by choosing Copy and then Paste from the Edit menu.**
   This pastes a copy of the view at the top of the views list.

To duplicate a view:

- Follow steps 1 and 2 in the previous procedure, then choose Duplicate from the Edit menu.

Note: When you copy and paste views, Extreme 3D retains the name of the original view. When you duplicate views, Extreme 3D appends a number to the new view's name. To avoid confusion, it's a good idea to rename views that have been copied or duplicated.

Any view from any Extreme 3D scene file can be copied for use into any other Extreme 3D file. By copying and pasting views from other Extreme 3D files you can build a library of custom views or create a customized Default.E3D file. For more information, see "Creating a custom Default.E3D file" on page 136 or the Reference section of the Extreme 3D Help system.

To use a view from another Extreme 3D file:

1. **Choose Open from the File menu and select a file whose views you want to copy.**
   If the Views browser is open when you open another Extreme 3D file, it updates to display the list of view names associated with that newly opened file.
2. **Select a view you want to copy from this file's views list and choose Copy from the Edit menu.**
3. **From the Scenes pop-up in the Window menu, select the name of the file into which you want to paste the view.**
   Again, if the Views browser is open when you select another Extreme 3D file, it updates to display the list of view names associated with that newly opened file.
4. **Click in the views list of the Views browser and choose Paste from the Edit menu.**
   The view is pasted into the view list and the current window updates to display the new view as it is applied to the scene.

Ordering the views list

Ordering the names of views in the view list can help you find the right view quickly. Names of new, copied, and duplicated views always appear at the top of the list, so you need to maintain any ordering strategy you adopt.

To change the order of view names in the view list:

- Click a view name in the views list of the Views browser and drag it to the position in the list where you want it to appear.

Deleting views

If you end up with too many views, or if views that were useful for, say, modeling are no longer useful for animating or lighting, you can delete them. Only the default view and camera view cannot be deleted.

To delete a view, either:

- Select the name of the view you want to delete from the views list and press Delete.
- Or select the name of the view you want to delete from the views list and choose Cut or Clear from the Edit menu.

Using multiple windows

By using multiple windows in Extreme 3D, you can have a variety of views open simultaneously. You can also output images of different sizes.

This section describes two ways of using multiple windows and views:

- Creating new windows and assigning views to them
- Using the four-view setup

Creating new windows

One way to have multiple views of your scene open at once is to create new windows and assign different views to each window.

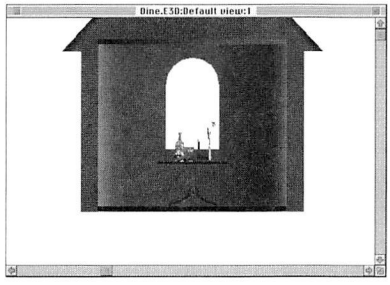
To create a new window:

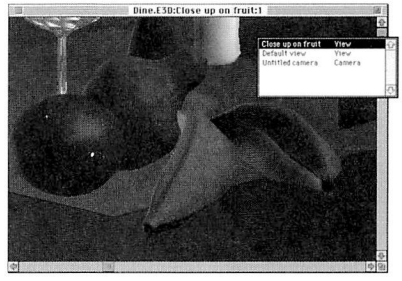
- Choose New Window from the Window menu. Extreme 3D creates a new window. By default it is assigned a new view that takes its settings from the current view. The new view is named Untitled View and is added to the views list of the Views browser.

Note: If you prefer, you can turn this option off in Preferences. To do this, choose Preferences from the Edit menu and click the Views page. Click the Create New View for New Window check box. With the option off, the current view is assigned to any new window you make and no new view is added to the views list of the Views browser.

To assign a different view to a window:

1. **Select a window, either by clicking its title bar or workspace, or by choosing it from the list of windows you see when you choose Scene from the Window menu.**
2. **Choose Views from the Window menu to open the Views browser.**
3. **Select any view from the Views list.**
   The window title bar displays the name of the view you have selected and the window displays that view.





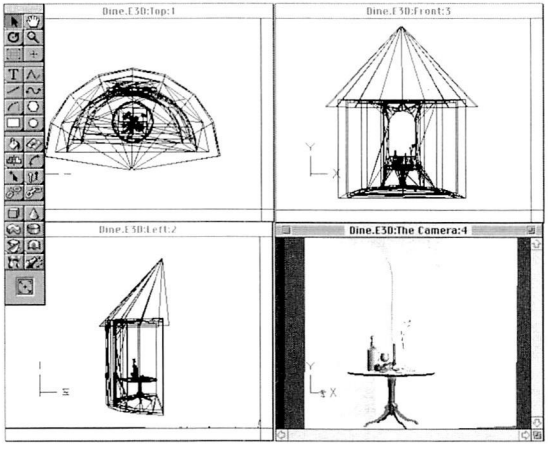
Each window can have a specific size and maximum render style associated with it. For more about these features and how they affect the way your images and animations are rendered, see Chapter Six, "Rendering."

Using the four-view setup

Another way to have multiple views of your scene open simultaneously is to use the four-view setup. It creates four new windows and assigns the camera view and the front, top, and left preset views to these windows. This way you can view your scene from these four views that provide you the most information about where objects are in three-dimensional space.

To use a four-view setup:

- Choose Four-View Setup from the Window menu. When Four-View Setup is chosen, all other windows are closed. All views except the camera view are set to a Max Render Style of wireframe.



Finding and organizing the elements of a scene

When you work in Extreme 3D you are creating a database of scene elements. A large scene, consisting of many views, objects, lights, and materials and their associated attributes can become very complex. Earlier in this chapter you saw how to use the Views browser to organize the views in a scene. This section describes how to use Extreme 3D's system of browsers to quickly access objects and other elements of the scene. It tells you how to:

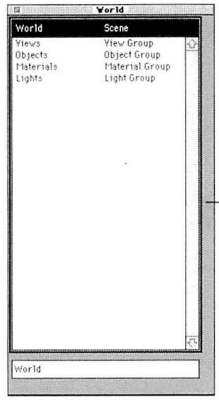
- Navigate the scene hierarchy with the World browser
- Find specific objects, lights, and materials in a scene

Navigating the scene hierarchy

The World browser is the master browser of Extreme 3D. It displays the hierarchy of the scene and the relationship of each element of the scene to that hierarchy. Child objects, for example, are listed below their parent objects. You can locate any element of the scene using the World browser.

To open the World browser:

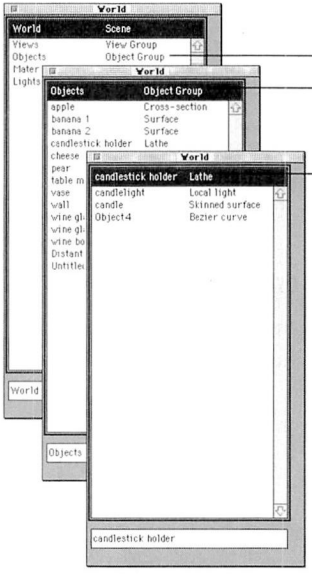
- Choose World from the Window menu.



The World browser as it appears when you first start Extreme 3D

The World browser as it opens when you first start Extreme 3D displays World at the top of its list. World is the root of the scene hierarchy. Each element in the list below World is a child of the world and represents a category of elements in the scene. All elements in the scene are categorized under one of these headings. By double-clicking the name of any element in the list you can browse through all the elements in that category.

Double-clicking the name of an element places its name at the top of the browser hierarchy list and, if it is a parent to other elements of the scene, displays their names in the list below it. The profiles from which surface objects are created are also displayed by name in the list beneath that surface object's name.



Double-clicking on Objects, moves Objects to the top of the list and displays all the objects in the scene. Double-clicking on one of the objects in the scene, displays the child objects of that object and the profiles that are its defining geometry.

Note: If an element is not a parent and does not have defining geometry, nothing appears below it in the World browser list.

When you open the World browser after you have been working in a scene file, it displays the category of scene elements you last worked with—objects, views, materials, or lights—and selects the current object, view, material, or light.

You can also use the keyboard to move in the World browser.

Press this key	To perform this operation
Up or Down arrow	Moves to the previous or next object in the list of objects
Home*	Moves to the first child in the list of objects
End*	Moves to the last child in the list of objects
Right arrow*	Moves to the parent of the current object
Left arrow*	Moves to the first child of the current object
Page Up*	Scrolls the list upward
Page Down*	Scrolls the list downward

* Windows only

To quickly toggle the World browser open or closed, or to pop it to the top of your stack of windows if it is buried:

- Press Control+B (Windows) or Command-B (Macintosh).

Note: When the World browser is the active window, you can find scene elements by name by typing the first few letters of the element's name. The World browser matches the letters you type to the element's name and selects it. This feature is case-sensitive.

Finding elements of the scene

As you begin adding objects, lights, and materials to your scene your collection of scene elements can grow quickly. The number of elements in a scene and the variety of angles from which you can view the scene can make it difficult to find the one object you want to change.

Finding elements by name

One way to find scene elements is by name using the Find command. The Find command searches the contents of your scene for the name of any element, selects it in the workspace if it is an object, and opens the browser with which it is associated.

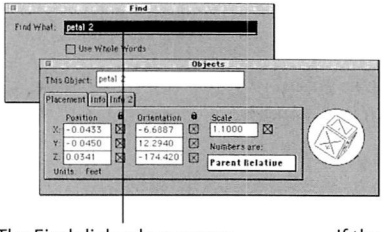
To find an element of the scene by name:

1 **Choose Find from the Edit menu.**
The Find dialog box appears.

2 **Enter the name of a scene element and click Find Next to perform the search.**
Extreme 3D finds the named element, selects it in the workspace if it is an object, and opens its associated browser.

3 **To find another scene element that contains this name, click Find Next again.**
Extreme 3D searches the scene hierarchy for another scene element of this name.

4 **To find all the scene elements that contain this name, click Find All.**
Extreme 3D finds all the named elements that match the entry and selects them in the workspace if they are objects.

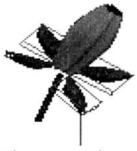


The Find dialog box opens the scene element's browser.

If the element exists as an object in the workspace, that object becomes selected.

To add an object to the current selection of objects in the workspace:

- Click Add to Selection in the Find dialog box.



Three petals were already selected when the Find, with Add to Selection checked, was performed.

The last petal was added to the selection.

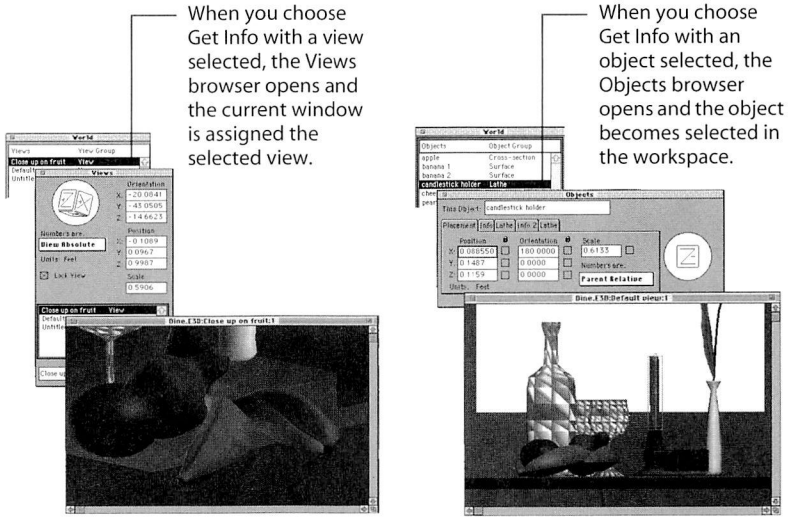
To constrain your search to exact name matches:

- Click the Use Whole Words check box in the Find dialog box.

Another way to find scene elements is by using the World browser and the Get Info command. Get Info opens the browser associated with the element that you select in the World browser. If an element is an object, it is simultaneously selected in the workspace when you select its name in the World browser.

To display an element's properties:

1. **Choose World from the Window menu to open the World browser.**
2. **Double-click through the object's hierarchy until you find the element you want more information about.**
3. **Select that element from the list and choose Get Info from the Edit menu.**
   The browser most appropriate to that element opens.



For more information about the use of specific browsers, see the chapters that specifically cover those scene elements. For more information about the Objects browser, see Chapter Three, "Modeling." For more information about the Lights and Materials browsers, see Chapter Five, "Lighting and Materials."

Finding hidden elements

If you select an object by name in the World browser but no object appears to be selected in workspace, the object may be hidden.

To show an object that has been hidden:

1. **Choose World from the Window menu to open the World browser.**
2. **Double-click the Objects heading and double-click your way through the objects hierarchy until you find the name of the object you are looking for.**
3. **Select the object's name in the World browser.**
4. **Choose Show from the Object menu, then choose Selected Objects.**

Tip: Optionally, you can choose Show All from the Object menu. This shows the camera object and all objects that are hidden, including those in hidden layers and those whose visibility states are animated. For more information about visibility states, see "Working with layers" in Chapter Three. For more information about the camera object, see "Animating the camera object" in Chapter Four.

Setting up your work environment

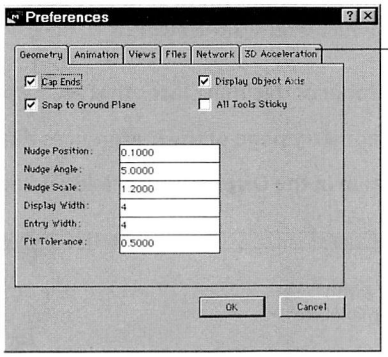
You have already seen how you can use preferences to change the display of the orientation axis and to set nudging values. This section demonstrates some additional preferences and commands that allow you to configure the Extreme 3D workspace to suit your working habits. For more information about geometry preferences, see Chapter Three, "Modeling." For more information about animation preferences, see Chapter Four, "Animating." For more information about files preferences, see Chapter Six, "Rendering."

Setting workspace preferences

Some preferences settings allow you to change defaults of the Extreme 3D workspace. All the preferences presented in this section are set in the Preferences dialog box.

To open the Preferences dialog box:

- Choose Preferences from the Edit menu.



Different types of preferences are on different pages.

Changing the default tool

Usually the arrow tool is the default tool. That is, Extreme 3D reverts to the arrow tool whenever you are through using another tool. However, you can change the default tool to any tool you choose.

To set a new default tool:

- Press F3 (Windows) or Option (Macintosh) while selecting the tool.

The default tool becomes active as soon as you have completed an action with any other tool. You might want to keep the tool you used most recently the active tool, rather than always reverting to the default tool.

To make the most recently selected tool always remain active:

1. **Choose the Geometry page of the Preferences dialog box.**
2. **Check All Tools Sticky.**

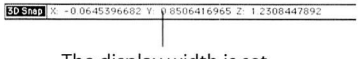
Changing the numbers of decimal places in the workspace

By default, the Extreme 3D tool space displays all feedback values with four decimal places. You can set this number higher or lower, depending on the degree of precision with which you want to work.

To change the number of decimal places that are displayed in the tool space:

1. **Choose the Geometry page of the Preferences dialog box.**
2. **Type a new value in the Display Width field and press Enter.**

The display width is set to four decimal places.



The display width is set to ten decimal places.

The number of decimal places you can enter in the tool space can be different from the number that is displayed. This can be useful if you need to enter very precise measurements, but don't want those measurements cluttering up the tool space. By default, you can enter four decimal places, but you can set this number to be higher or lower.

To change the number of decimal places for numerical entry in the tool space:

1. **Choose the Geometry page of the Preferences dialog box.**
2. **Type a new value in the Entry Width field and press Enter.**

Setting units of measurement

You can choose the units of measurement you want to use for the scale of your scene. Choose units of measurement from inches to meters. The units of measurement that you choose are used by Extreme 3D to set the world-to-grid ratio. The ***world scale*** sets the units used on the screen. The ***grid scale*** represents the size an object would be in the real world.

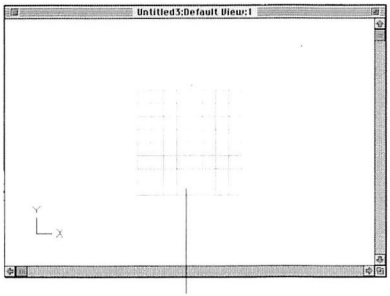
The Extreme 3D default is one inch on the screen (world scale) equals one inch in the real world (grid scale).

To change the unit of measurement and the world-to-grid ratio:

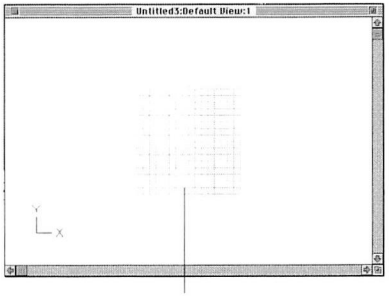
1 **Choose Units from the Object menu.**

2 **Choose the units of measurement that you want for World and Grid scales from the pop-up.**

3 **Type in the number of units you want to use to create the scale and grid ratios.**



The world-to-grid ratio is set to one inch: one inch.

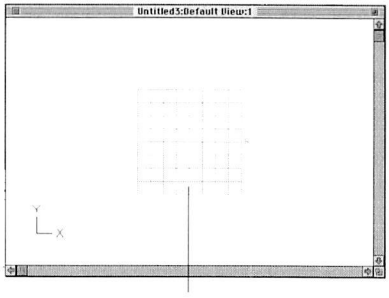


The world-to-grid ratio is set to one inch: two inches.

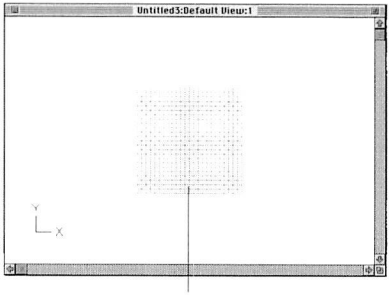
Changing the world-to-grid ratio changes the number of grid divisions in the working plane. You can also change the number of grid divisions in the working plane independently from changing the world-to-grid ratio.

To change the number of grid divisions in the working plane:

- Type a value in the Divisions text entry field in the Units dialog box.



The grid divisions are set to four.



The grid divisions are set to twelve.

Creating a custom Default.E3D file

You can tell Extreme 3D to use the preferences you set and many of the customizations you make to your Extreme 3D environment as default settings by changing the Default.E3D file. Extreme 3D uses the settings in the Default.E3D file when you create a new file. This is especially useful for settings you know you want used for all your Extreme 3D files, for example, using centimeters instead of inches as the default unit of measurement, or changing the default background color. You can also create custom lights and views and store them in this file.

To customize the Default.E3D file:

1. **Choose New from the File menu to open a new Extreme 3D file.**
2. **Choose Preferences from the Edit menu and use the Preferences dialog box to set the Extreme 3D preferences you want as your defaults.**
3. **Choose Units from the Objects menu and set the units of measurement you want to use as your default.**
4. **Create custom lights or views you want to save as defaults.**
5. **Save the file as Default.E3D in the Scripts folder inside the Extreme 3D folder.** This replaces the standard Default.E3D file and opens subsequent files using the preferences and settings you specified.

3

Chapter Three
Modeling

This chapter describes the modeling concepts that you should know to get the most out of Extreme 3D's modeling features. It includes sections on:

- Introducing the modeling environment
- Creating profiles
- Creating surface objects
- Assembling models

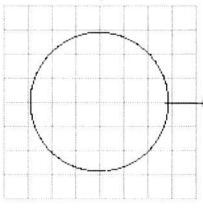
Introducing the modeling environment

This section discusses the basic steps and principles behind creating models in Extreme 3D. You'll see how to:

- Create profiles, turn them into surfaces, and combine them into models
- Work with an object's geometry
- Move, scale, and rotate objects in the workspace
- Link objects

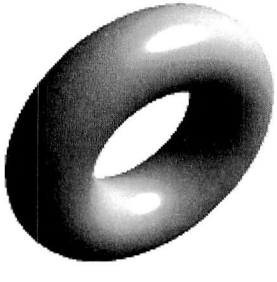
Profiles, surface objects, and models

A profile is the fundamental unit of all models in Extreme 3D. Typically, you start building a model by drawing profiles using the line, polyline, square, rectangle, polygon, ellipse, circle, arc, or spline tools.



This circle profile was created using the circle tool.

After you have created one or more profiles, you can use the 3D geometry tools to create surface objects from them. Different tools can create different objects from the same profile, as shown in the following figure.



This surface object was created using the lathe tool on a circle profile.

This surface object was created using the extrude tool on a circle profile.

As you create surface objects, you can position them, orient and align them with each other, and link them together to create models.

This model was built from surface objects that were created from circle, square, and spline curve profiles.

Understanding object geometry

After you create a surface object, the profiles and settings of the modeling tool used to create it are still available. They make up the object's defining geometry. You can open the geometry of a surface object and edit it. Editing an object's geometry modifies the object.

To open the defining geometry of a selected surface object:

- Double-click the surface object or choose Open Geometry from the Object menu.

You can expose two even more elementary levels of a surface object's geometry. This is called ***simplifying geometry.***

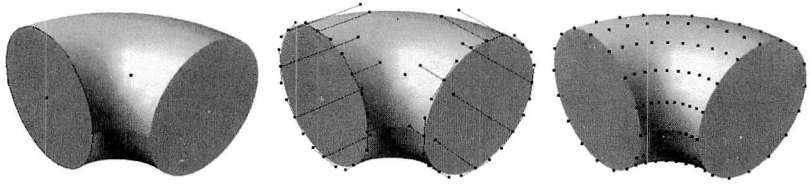
To simplify a surface object's geometry:

- Choose Simplify Geometry from the Object menu.

Note: Once you simplify a surface object, you cannot move back to its previous level of geometry.

A surface object that has been simplified once exposes its ***surface geometry*** when opened. At this level the object appears as a matrix of spline-based control points.

Most surface objects that have been simplified twice expose their ***polymesh*** geometry. At this level, the object's surface is defined as a matrix of polygons. Each corner, or ***vertex***, of each polygon is displayed as a control point. The following figure illustrates the different geometry levels for the same object.



Defining geometry *Surface geometry* *Polymesh geometry*

Note: Surface objects with holes that have been simplified twice expose ***polylist*** geometry. For more information, see "Editing 3D geometry" on page 199.

Tips for modeling in Extreme 3D

When you assemble two or more surface objects you can make more complex objects, or models. Modeling can be performed intuitively, like sketching, or precisely, by using exact measurements. Different tools can be used to produce similar results and the same object can be created in a number of different ways.

If you're experienced in three-dimensional modeling, you'll find Extreme 3D's modeling tool set easy to approach and use. If you're new to 3D modeling, you should familiarize yourself with the tutorial before reading this chapter. Both new and experienced users should read Chapter Two, "Navigating the workspace."

Before you begin modeling

Before you begin creating models, it's a good idea to make some preparations.

- **Collect resource materials**—If you're modeling a real-world object, collect examples that you can use. For example, if you're modeling an airplane, find a plastic scale model of the plane—many of them come with cross-section drawings.

  You can copy or import images from other applications. For example, you might want to use some of the sample models included in your Extreme 3D package, or import a blueprint or illustration from Macromedia FreeHand for use as the basis of the Extreme 3D image.

- **Analyze the model**—Think about what tools you'll use to build it. For models that have many similar parts, create a "master" profile and use copies to create further geometry.

  Look for symmetry that can be mirrored to make the final model. Not only do you have to create only half of the object, but the result looks more exact because mirrored parts are identical.

  Look for objects with holes in them and plan ahead. It's a good idea to build the model around a main object with holes in order to accommodate parts that need to fit into the hole.

Managing complex models

Modeling in Extreme 3D allows you to quickly create a large number of objects. The following strategies can help you organize and manage the models you make.

- **Create model components**—You might first work in two dimensions, creating and combining all the profiles you need, and then turning them into three-dimensional objects using the 3D geometry tools. Alternatively, you might create a profile or two to establish the scale of the model, turn it into a surface object, then incrementally add other surface objects to it.

  For very large models, it can be useful to create model components in separate files and then, when you've completed all the components, copy and paste them into a single file.

- **Edit objects as you create them**—Spend time making objects correctly from the beginning, rather than counting on editing them later. If you have to edit an object, analyze the type of changes you want to make and edit the object at the most appropriate geometry level.

- **Name objects as you create them**—Name objects meaningfully so that you can take full advantage of Extreme 3D's find feature and of the database management capabilities of the browsers. For more information, see "Finding and organizing the elements of a scene" in Chapter Two.

- **Use browsers**—Use the World browser to find and select objects. Use the Objects browser to scale, rotate, and move objects in precise amounts, and to constrain movement to only one or two axes. For information about using these browsers, see the Reference section of the Extreme 3D Help system.

- **Assign objects to layers**—Use the Layers browser to assign objects to layers, then hide and show them as they are needed. For more information, see "Working with layers" on page 217.

Moving objects

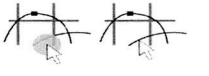
It is a rule in the Extreme 3D world that moving an object moves it parallel to the working plane. The only way to break this rule is to move an object while pressing a modifier key on your keyboard. For more information, see "Constraining snapping with modifier keys" on page 143.

To move an object:

- Select the arrow tool, click the object you want to move, and drag it to its new location in the workspace. During a move, a bounding box appears around the 3D object.

Snapping

Snapping is always active in Extreme 3D. As you move the cursor, Extreme 3D searches in the ***hit radius***, an area four pixels in diameter around the cursor. Extreme 3D uses a set of rules, shown in the following table, to determine the point to which it snaps:

When Extreme 3D finds	The cursor snaps to	As shown in the figure
Object control points within the hit radius	The closest control point	
Any profiles or 3D geometry intersecting with the hit radius	The closest point of intersection	
Any objects within the hit radius	The closest point on the object	
The working plane	The working plane	

Tip: The scale of the view affects the hit radius. Zoom in to snap to small objects such as control points.

Constraining snapping with modifier keys

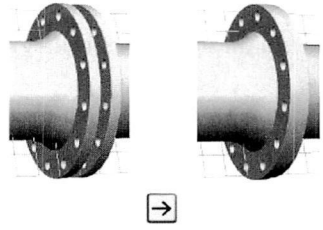
You can activate additional snapping options using modifier keys. When you hold a modifier key, the current snap option is displayed in the tool space. The following table describes the behaviors of modifier keys.

Modifier key	Snapping constraint
v	Constrains the movement of the object vertically across the working plane, along the y-axis.
h	Constrains the movement of the object horizontally across the working plane, along the x-axis.
n	Constrains the movement of the object along a line normal to the working plane, along the z-axis.
p	Constrains the movement of construction objects to be perpendicular to geometry in the hit radius.
t	Constrains the movement of profiles to be tangent to other profiles that are in the same plane and within the hit radius.
o *	Snaps to the plane on which the selected object was created.
x	Disables snapping.
2	Snaps to a location on the working plane.
3	Snaps to a location in 3D space, off the working plane.

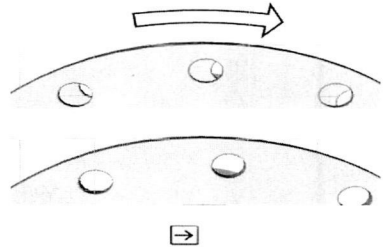
* This is the letter o, not the number zero.

Nudging objects

You can move, scale, and rotate objects in very small increments in the workspace—nudge them—using the arrow keys on your keyboard. Select the arrow tool, select the object(s) you want to move, and use the keyboard to nudge the objects.



The left pipe flange has been nudged using the arrow key so that it meets the right pipe flange.



Then, the rotation of the back pipe flange is nudged so the holes line up with the holes in the front pipe flange.

Note: You can specify nudging increments in the Preferences dialog box.

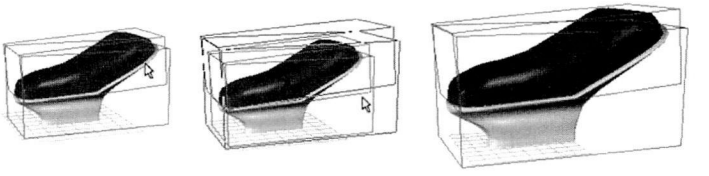
Use modifier keys to nudge objects precisely. The following table lists modifier keys:

Press this	To do this
Up, Down, Left, or Right arrow key	Move the selected objects in a direction relative to the working plane
Shift + Up arrow or Shift + Down arrow	Move the object forward or backward on the z-axis of the working plane
Up or Down arrow key and: F3 or F4 (Windows) Option or Command (Macintosh)	Rotate the object in the specified increment and at the specified angle
One of the arrow keys and: F2 (Windows) Control (Macintosh)	Scale the selected objects by a factor specified in the Preferences dialog box

You can also use nudging to move individual control points on an object. This technique allows you to perform precise editing directly in the workspace.

Scaling objects

When you scale an object, you make it proportionately smaller or larger.



To scale an object:

- Select the arrow tool and drag the object you want to scale while pressing F2 (Windows) or Control (Macintosh). Dragging down makes the object larger. Dragging up makes the object smaller.

Scaling objects using the Objects browser

You can also scale an object by entering a scale value in the Scale field of the Objects browser. The scale of an object is represented with a decimal number—2.0 equals 200 percent; 0.5 equals 50 percent.

To scale an object using the Objects browser:

1. **Open the Objects browser by choosing Objects from the Window menu.**
2. **Select the object that you want to scale, type a value in the Scale field, and press Enter.**

For more information about using the Objects browser, see the Reference section of the Extreme 3D Help system.

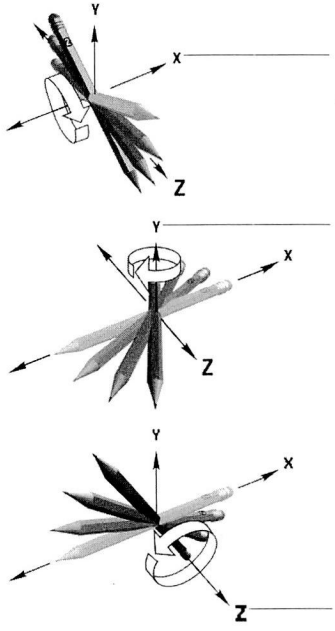
Rotating objects

You can rotate an object around any of its three axes.

To rotate an object:

1 **Select the arrow tool, then select the object(s) you want to rotate.**

2 **Drag the object in the direction you want while pressing the modifier key that specifies the type of rotation.**



Drag the object horizontally while pressing F3 or F4 (Windows), or Option or Command (Macintosh), to rotate the object around the y-axis.

Drag the object vertically while pressing F4 (Windows) or Command (Macintosh) to rotate the object around the x-axis.

Drag the object vertically while pressing F3 (Windows) or Option (Macintosh) key to rotate the object around the z-axis.

Tip: To rotate on all three axes, alternate modifier keys as you rotate. By alternating dragging with and without holding down the modifier key, you can both move and rotate the object in a single operation.

Rotating objects using the Objects browser

There are two ways to rotate objects using the Objects browser. You can type values or move the trackball.

To rotate an object using the Objects browser:

1. **Open the Objects browser by choosing Objects from the Window menu.**
2. **Select the object.**
   The values indicating the selected object's position, orientation, and scale appear in the appropriate fields of the Objects browser.
3. **Type new values in the appropriate fields and press Enter or Tab.**
   Pressing Tab moves you between the x, y, and z fields.
4. **To rotate the object visually, drag the trackball on the right side of the Objects browser.**
   As you drag the trackball, the values displayed in the Orientation fields change to indicate the modified orientation of the object, and the object moves in the workspace.

Note: If an object has not been previously rotated, and if the original view has not been changed, the trackball appears as a square; you are looking at one face of the cube that represents the object's bounding volume.

For more information about using the Objects browser, see the Reference section of the Extreme 3D Help system.

Custom rotation and placement

In addition to the arrow tool that allows you to rotate an object around its center point, you can use a group of placement tools to perform custom rotation and placement of objects upon control points, lines, and the geometry of other objects.

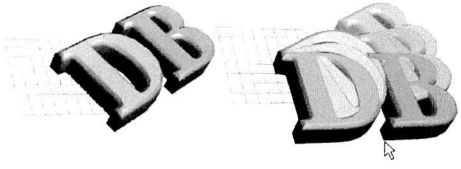
Use the custom rotation tools to achieve rotations that are difficult to control numerically in the Objects browser, such as off-axis rotations and rotations around an axis that's not aligned with the object's axis.

- Use the rotate point tool to rotate geometry around a defined point.
- Use the rotate axis tool to rotate geometry around an arbitrary axis.
- Use the placement tool to orient surfaces of objects to each other.

To rotate around a defined point:

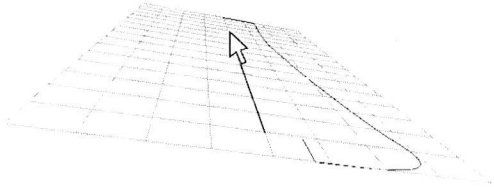
1 Select the rotate point tool and click a point in the workspace that defines the center of rotation.

2 Click a reference point on an object and rotate the reference point by dragging around the center of rotation, or type a rotation angle in the tool space and press Enter.

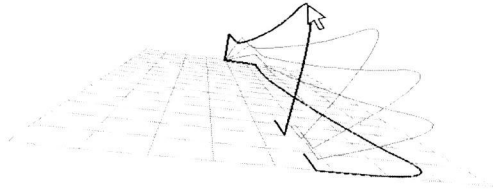


To rotate around a defined axis:

1 Select the rotate axis tool and click two points (or drag a line) in the workspace to define the axis



2 Click a reference point on the object you want to rotate and drag to rotate that reference point around the axis.



To orient object surfaces to each other:

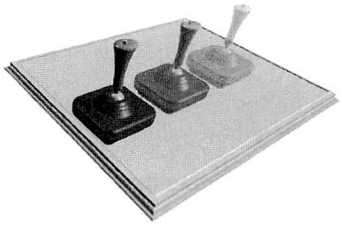
1. **Select the placement tool, click a reference point on an object, and drag that point to snap it to another object in the workspace.**
2. **Click a new point on the first object and drag the object to rotate it around the original point.**
3. **Click a third point on the first object and drag it around the axis defined by the two previous snap points.**

Linking

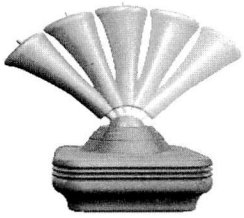
You can use a technique called ***linking*** to organize the objects in a model into a logical hierarchy.

When you link two objects, one becomes the ***parent*** and the other becomes the ***child***. This relationship defines how the objects are positioned and oriented, and how they move in relationship to one another.

For example, you can define a joystick handle as the child of the joystick base. Furthermore, you can define different types of links to simulate the behavior of a real-world object.



The joystick handle is linked to the base. When you reposition or reorient the base in the workspace, the handle is reoriented or repositioned as well.



The joystick handle is linked to the base using a ball-joint link. You can move the handle freely in the base.

For more information, see "Linking objects" on page 205.

Creating profiles

This section discusses the fundamental unit of modeling—profiles. You'll see how to:

- Use tools to draw profiles
- Modify profiles
- Edit the geometry of profiles

For more information about using any of Extreme 3D's drawing tools, see the Reference section of the Extreme 3D Help system.

Drawing profiles

Use the drawing tools in the Extreme 3D tool palette to create profiles. These tools include line, polyline, spline, square, rectangle, ellipse, circle, polygon, arc, and text tools. If you've used two-dimensional drawing applications, you're probably familiar with most of these tools. Following are some concepts to remember as you begin using Extreme 3D's drawing tools:

- You can create a profile in either of two ways:
  - Select the tool and drag the desired shape or size in the workspace.
  - Define the profile as precise values in the tool space and let Extreme 3D draw the profile based on those values.
- You can modify profiles before turning them into 3D objects.
- For tips about using a tool, refer to the status bar. Make sure Show Status Bar is checked on the Window menu.

Drawing lines, polylines, and splines

Use the *line* tool to draw a straight line in the workspace.

To draw a line:

- Click the line tool, then drag a line in the workspace. Instead of dragging, you can also click the beginning and end points of the line.

Use the *polyline* tool to create profiles made of more than one line segment. The polyline tool can create open polylines or closed polygons.

To draw a polyline:

1 **Click the polyline tool, then click points in the workspace to define the polyline's segments.**
You can also click and drag the length of each line segment.

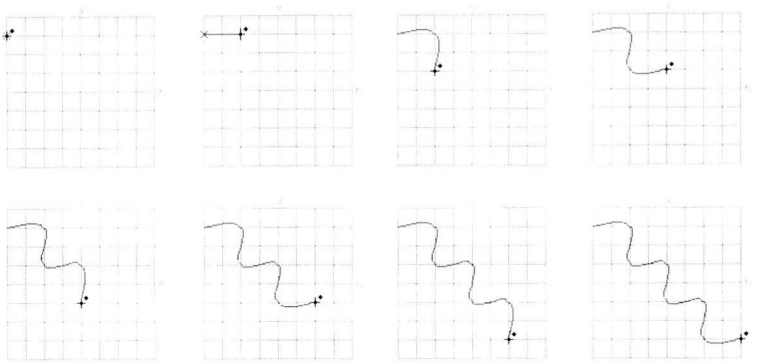
2 **Double-click the end point of the polyline to complete it.**
Double-click exactly on the start point to define a closed polygon. Notice that the clear diamond appears next to the cursor when it's directly over the profile.

Use the *spline* tool to create open or closed *Bézier* spline curves. You can draw a spline curve in three different ways:

One way to draw a spline curve is to:

1 **Select the spline tool, then click in the workspace to define a starting point.**

2 **Click again to define as many control points as you want. Double-click to define the end point.**
Extreme 3D creates a default curve following the points.



A spline curve created by clicking repeatedly in the workspace

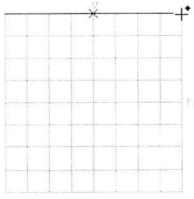
A second way to draw a spline curve is to:

1 **Select the spline tool, then click and drag in the direction you want the curve to be drawn.**
As you drag, the cursor draws one of two endpoints on a ***tangent line,*** a line tangent to the curve that passes through the control point. The two points of the tangent line pass through this stationary control point and move in opposition to each other around it. When you release the mouse, the tangent line remains.

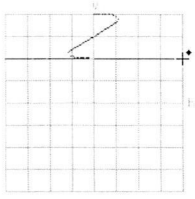
When you release the mouse, the position of the tangent line end points sets the starting direction of the next curve. By adjusting the length of the tangent line, you can adjust the angle of the curve.

2 **Click to define a second control point and drag to position the end points of its tangent line, setting the height and slope of the next curve segment.**

3 **Release the mouse.**



Click and drag to position the end points of the tangent line.



Repeat the process with a second control point.

Repeat the process three more times to create this spline curve.

A third way to draw a spline curve is to:

1 **Select the spline tool, then click and drag the tangent line while holding F3 (Windows) or Option (Macintosh).**
This creates a sharp corner on the spline curve.

2 **Continue adding control points on the spline, then double-click the end point to complete the spline curve.**

Tip: To create sharp corners on an existing spline curve, press B while you manipulate the tangent lines. This breaks the tangent lines, allowing you to create the angle you want.

To define a closed spline curve:

- Place the end point by double-clicking exactly on the start point. Notice that the clear diamond appears next to the cursor when it is directly over the profile.

Line, polyline, and spline profiles can also be created by defining precise values. Use the tool space to specify the values required by the tool you're using.

To use the tool space:

1. **Select the line, polyline, or spline tool.**
2. **Press Tab or click in the tool space to make the tool space active.**
3. **Enter values for each line angle and length in the tool space and press Enter.**
   The default tool space values for polyline segments are an angle of 0 units and a length of 1 unit, or whatever values you last entered.

Note: You can convert polylines into splines using the Smooth Polylines command. For more information, see "Converting polylines into splines" on page 161.

Drawing squares, rectangles, and regular polygons

- Use the square tool to draw a rectangle with equal sides, forming a perfect square.

- Use the rectangle tool to draw a rectangle with sides of any height and width.

- Use the regular polygon tool to draw a polygon with equal sides and equal angles.

- Use the center-corner toggle to switch between drawing the profile from center to corner and drawing it from corner to corner.

To draw a square, rectangle, or regular polygon:

1. **Select the square, rectangle, or regular polygon tool.**
2. **Drag in the workspace to define the profile's size.**
   If you prefer, you can click again instead of dragging to define the size of the profile.

To use the tool space:

- In the tool space, enter the width value for a square, or enter the width and height values for a rectangle, or enter the radius and the number of sides for a regular polygon and press Enter.

Drawing circles and ellipses

- Use the circle tool to draw a perfectly round circle.

- Use the ellipse tool to draw an ellipse of any height and width.

- Use the center-corner toggle to switch between drawing the profile from center to edge and drawing it from edge to edge.

To draw a circle or an ellipse:

1. **Select the circle or ellipse tool.**
2. **Click to specify the starting point of the circle or ellipse, then drag in the workspace.**
   If you prefer, you can click again instead of dragging to define the edge of the circle or ellipse.

To use the tool space:

- In the tool space, enter a radius of a circle, or the height and width of an ellipse, and press Enter.

Drawing arcs

Use the arc tools to draw arcs of any size or angle. Extreme 3D has two different arc tools. Each has a specific application:

- Use the center arc tool when you know where the center point of the arc will be positioned.
- Use the tangent arc tool when you know where the end points of the arc will be positioned.

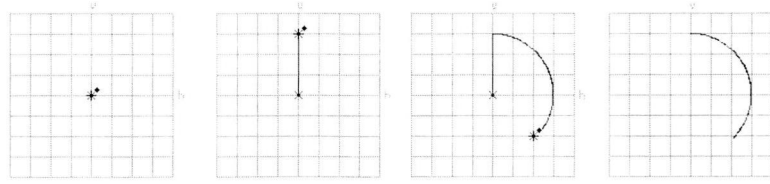
Use the center arc tool to specify a center point, a radius, the starting point for the arc, and the angle of the circle that includes the arc.

To draw a center arc:

1 **Select the center arc tool and click a point to position the center point of the arc.**

2 **Click again to position the start point for the arc. This defines the radius and the starting direction of the arc.**

3 **Click a last time to position the end point for the arc. Extreme 3D determines the angle of the arc.**
You can type the angle you want in the tool space instead of clicking the last time.



Click the center point. *Click the start point.* *Click the end point.* *Extreme 3D creates the arc.*

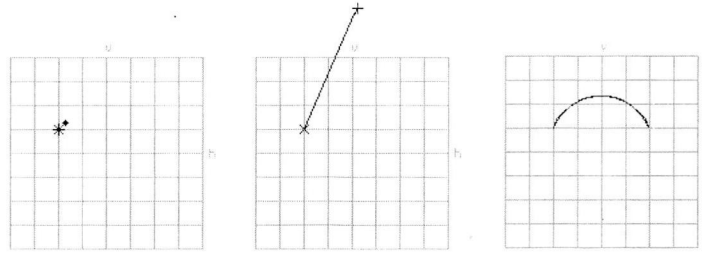
Use the tangent arc tool to draw an arc that touches but does not intersect another line, curve, or surface at a single point. For example, you might use this tool to draw an arch that is tangent to a pair of columns in an architectural model.

To draw a tangent arc:

1 **Click the tangent arc tool and click a point that specifies a starting point for the arc.**

2 **Click a point in the workspace to define the direction of the tangent line.**
You can also drag to define the direction of the tangent line.

3 **Click an end point for the arc.**



The three steps of drawing a tangent arc.

Center arc and tangent arc profiles can also be created by precise value. Use the tool space to provide the values required by the tool you are using.

To use the tool space with the center arc tool:

- Click the arc's center, and then use the tool space to enter values for the radius, the starting direction (expressed in degrees), and the angle, and press Enter.

To use the tool space with the tangent arc tool:

- Click to define the center of the arc, then use the tool space to enter values for the tangent angle, chord angle, and chord length, and press Enter.

Drawing font profiles

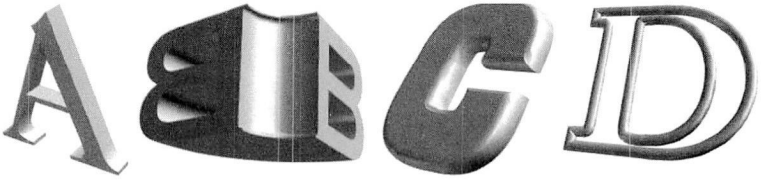
Use the text tool to draw outlines of font characters as spline curves.

To create font profiles:

1. **Select the text tool and click a point in the workspace where you want to place the text.**
   A control point appears in the workspace and a text insertion cursor appears in the tool space.
2. **Type the text in the tool space and press Enter.**
   The text appears as character outlines in the workspace. When you type multiple characters, Extreme 3D automatically links each character to the first character in the text string.

Note: You can double-click the text tool in the tool palette to open the Text Preferences dialog box, where you can specify the font style and size you want to use. For more information on text preferences, see the Reference section of the Extreme 3D Help system.

Each outline in text is a closed spline curve object (or a polyline object if no curves are present) that you can modify and use to generate a 3D object. Characters that contain holes (such as a, b, e, and g) are created as two or more spline curve objects. If you extrude all of a character's outlines into a 3D object, Extreme 3D automatically creates holes for the inner outlines.



These 3D characters were created by drawing letters with the text tool and turning them into three-dimensional objects using the 3D geometry tools.

Copying and duplicating profiles

You can copy and paste or duplicate any profile.

To copy and paste a profile:

1. **Select the profile(s) you want to copy and choose Copy from the Edit menu.**
2. **Deselect the profile you just copied.**
3. **Choose Paste.**
   The copy of the profile is pasted precisely over the original profile.

Note: If the original profile remains selected when you choose Paste, Extreme 3D replaces the selected profile with the new one, instead of creating an additional copy.

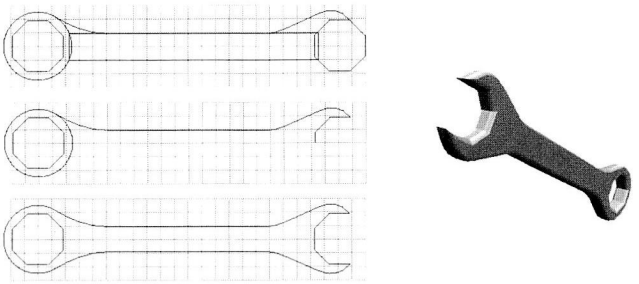
To duplicate a profile:

- Select the profile(s) you want to duplicate and choose Duplicate from the Edit menu. Extreme 3D creates an exact copy of the selected profile(s), offsetting the duplicate slightly.

For more information about copying, pasting, and duplicating profiles, see "Assembling models" on page 205.

Modifying profiles

Although you can generate a variety of three-dimensional surfaces from the basic set of profiles, you'll often want to modify and combine profiles (or parts of profiles) to create ***compound profiles***. For example, you could create the profile of a wrench by combining several profiles.



This wrench was created from a rectangle, two regular polygons, a circle, and two spline curves. Superfluous pieces of the profiles were cut away using the trim tool, and the profiles were joined using the Join Profiles command.

You can modify profiles to create the exact shape you need to generate 3D objects.

To modify a profile:

- Use the trim tool when you want to cut a specific section or sections out of a profile.

- Use the offset tool when you want to create an offset copy of a profile. You can also create inset copies using the offset tool with a negative value.

- Use the 2D mirror tool to mirror the copy, flipping it in the workspace, or to create a mirrored copy of a profile.

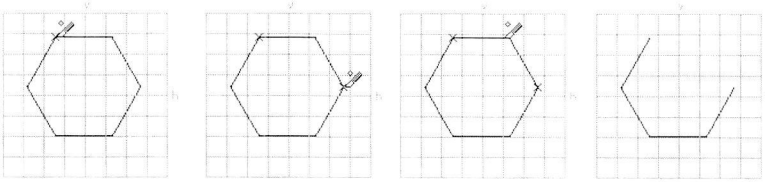
- Use the fillet tool to round the corners of a profile.
- Use the Join Profiles command from the Object menu to combine profiles and then work with the result as one profile.
- Use the Smooth Polylines and Fit Polylines commands from the Object menu to make spline curves out of polylines.

Trimming objects

Use the trim tool to cut sections out of profiles. This is useful for creating irregular profiles.

To trim a profile:

1. **Select the trim tool.**
2. **Click two points on the profile that define the trim boundaries.**
3. **Click the portion of the object that you want to remove.**
   Extreme 3D trims the portion from the object.



The steps for trimming a profile with the trim tool.

To break a profile at a single point:

- Select the trim tool and press F3 (Windows) or Option (Macintosh) and click once on the profile where you want it to break.

Creating offsets

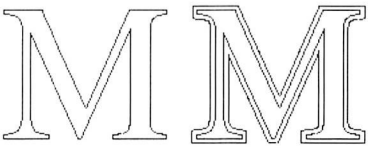
Use the offset tool to create an offset copy of a profile. Offsetting is especially useful for creating objects with a controlled wall thickness, such as pipes, and for creating text effects. Use offsetting rather than duplicating and scaling when you need to control the exact placement of the second profile in relation to the first.

To create an offset:

1 **Select the offset tool and click the profile you want to offset.**
The tool space displays the Extreme 3D default offset distance of 0.1 units or the offset distance you specified the last time you used the tool.

2 **Drag away from the original profile, or enter a value for the offset in the tool space and press Enter.**

3 **Release the mouse to complete the offset.**



The profile is offset proportionally to the distance you drag. For a closed profile, dragging toward the profile center or entering a negative number in the tool space makes the offset smaller than the original profile.

Creating mirrored profiles

Use the 2D mirror tool to mirror a profile across an axis.

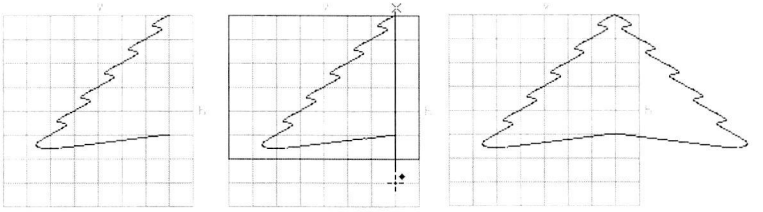
To mirror a profile:

1 **Select the 2D mirror tool, then select the profile to mirror.**

2 **Specify the axis of the mirror by clicking two points in the workspace, or click and drag the axis.**
Extreme 3D redraws the profile across the axis as a mirror image of the original profile.

To retain both the original profile and its mirror image:

- Double-click the 2D mirror tool to open the Mirror Preferences dialog box and make sure the Copy Mirrored Objects option is checked. This option is especially useful for creating symmetrical profiles.



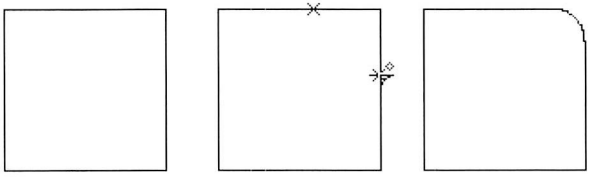
Select the profile you want to mirror. *Use the 2D mirror tool to define the axis.* *When you release the mouse, Extreme 3D creates the mirrored image.*

Filleting profiles

Use the fillet tool to replace the corners of angular profiles with arcs. You can fillet any line, polyline, regular polygon, square, or rectangle, as well as splines that display corners. Filleting might change the geometry of the profile; for example, a filleted rectangle becomes a polyline.

To fillet a profile:

1. **Select the fillet tool.**
   The tool space displays a default radius of .25 units or the value of the last fillet arc radius you specified.
2. **To change the radius of the arc, enter a new value in the tool space.**
3. **Click a point on both sides of the corner you want to fillet.**
   You don't have to be exact; Extreme 3D automatically calculates where the fillet begins and ends.



When you use the fillet tool on a profile, Extreme 3D replaces the corner with an arc, using the radius specified in the tool space.

After a fillet is performed, the resulting arc is a separate profile. You can use the Join Profiles command, described in the following section, to join the arc to the original profile again.

Joining profiles

The Join Profiles command joins separate profiles (lines, polylines, arcs, and spline curves) into a single compound profile that can be manipulated and edited like any other profile.

- If any of the original profiles are curves, the joined profile becomes a spline.
- If any of the original profiles are lines or polylines, the joined profile becomes a polyline.

To join profiles:

1. **Drag the profiles so that the points where you want to join them coincide.**
   You can use a modifier key to snap the endpoints together. You might need to zoom in on the area to ensure that the points snap to each other. For more information, see "Snapping" on page 142.
2. **Shift-click or drag a marquee to select al! profiles to be joined.**
3. **Choose Join Profiles from the Object menu.**
   Extreme 3D joins the profiles into a single spline curve or polyline.

Converting polylines into splines

Both the Fit Polylines and Smooth Polylines commands convert selected polyline profiles to splines.

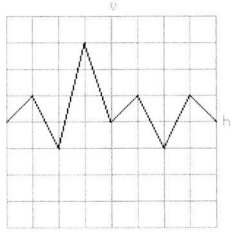
- The Smooth Polylines command creates a curve that passes through and is tangent to the midpoint of all line segments between the first and last line segments.
- The Fit Polylines command changes polyline profiles into splines by approximating the polyline's control points and rounding the edges.

  Use the Fit Tolerance setting on the Geometry page of the Preferences dialog box to specify how closely the fitted profile follows the shape of the original. The smaller the fit tolerance setting, the more closely the fitted profile will approximate the original profile.

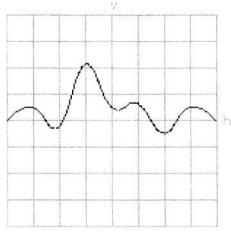
Note: Fit Polylines reduces the number of control points in the profile. Smooth Polylines does not.

To smooth or fit a polyline profile:

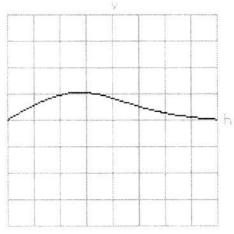
- Select the polyline profiles you want to affect and then choose either Smooth Polylines or Fit Polylines from the Object menu. Extreme 3D modifies the selected profiles, redrawing them as spline curves.



The original polyline profile.



The effect of the Smooth Polylines command on the polyline profile.



The effect of the Fit Polylines command on the polyline profile.

Editing profiles

You can change the shape of a profile by opening it for editing and modifying its control points. Any profile can be opened for editing, including rectangles, splines, ellipses, regular polygons, and lines.

An opened profile displays the control points of its current geometry level. For example, an unsimplified profile that's opened for editing displays its defining geometry.

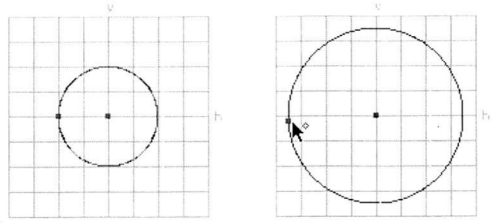
To open a profile:

- Double-click it or select the profile(s) with the arrow tool and choose Open Geometry from the Object menu. Extreme 3D opens the profile, displaying control points for editing.

To close a profile:

- Double-click it or select the open profile(s) with the arrow tool and choose Close Geometry from the Object menu. When a profile is closed, it returns to a state in which its geometry cannot be modified.

Once a profile is opened, the control points of its current geometry level can be manipulated to change the profile.



By dragging a control point on the circumference of the circle profile, you can change the circle's diameter.

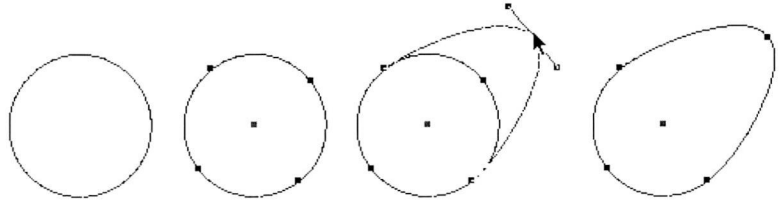
Editing simplified profiles

In addition to editing a profile's defining geometry, you can simplify any profile. When you simplify a profile that contains curves, it becomes a spline. When you simplify a rectangle, square, or regular polygon, it becomes a polyline. (Use the Smooth Polylines command to turn polyline profiles into splines.)

Editing a profile as a spline curve gives you more precise control over the shape of the profile.

To simplify a profile:

- Select a profile and choose Simplify Geometry from the Object menu.



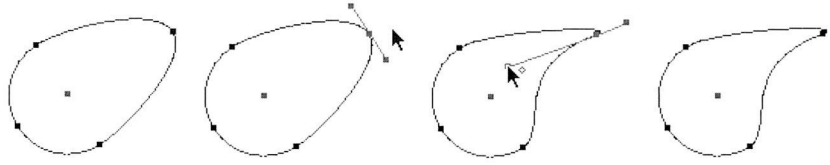
When you open the simplified circle profile and drag a control point, you create a bump.

If you haven't done anything since changing the level of geometry, you can return to a higher level of geometry by choosing Undo or History Backward from the Edit menu. If you're not sure of a profile's geometry level, select the profile and look at the profile's type on the third page of the Objects browser.

Tip: If you're going to change geometry levels, it's a good idea to duplicate the profile before you begin so you can return to the original level of geometry if you want to.

Editing spline curves

When you select a control point on a spline curve, the point displays tangent lines. You can use these lines to change the shape of a curve by dragging one of the points on either end of the line. You can rotate the tangent line endpoints around the control point or you can lengthen or shorten the tangent line.



A tangent line is twisted to change the shape of the simplified profile.

While dragging a control point or the endpoints of tangent lines, you can hold down the appropriate modifier key to snap the point to other geometry or to constrain its movement in the workspace. This allows you to drag points off the working plane and to create custom profiles for generating 3D geometry. For more information, see "Snapping" on page 142.

Tip: Choose Control Points from the Object menu to use the Select First Control, Select Next Control and Reverse Ordering options for control points.

Adding control points

Use the control point tool to add control points directly to lines, polylines, and spline curves. To add control points to arcs, circles, ovals, squares, or rectangles, you must simplify, smooth, or fit them first. After adding a control point, you can move it to modify the shape of the profile.

To add a control point:

- Select the control point tool and click a point on the profile where you want to add the control point. If the profile is not already open for editing, Extreme 3D opens it.

You can also use the control point tool to remove existing control points from a profile. This might also change the shape of the profile.

To delete a control point:

- Select the control point tool, and press F3 (Windows) or Option (Macintosh) while clicking the control point that you want to remove.

Tip: Save copies of your profiles before using one of the 3D geometry tools on them. You might find it convenient to put the copies in another file. Or use the Hide Selected Objects command from the Object menu to get the duplicates out of the way while you're working.

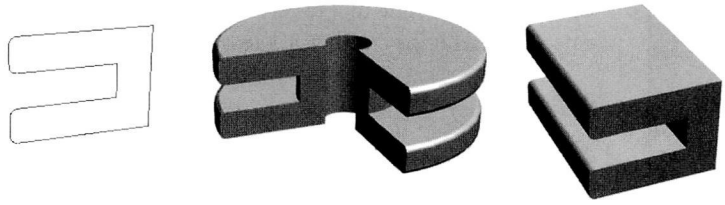
Creating surface objects

This section discusses creating surface objects (sometimes called "surfaces"). You'll see how to make surface objects, deform surface objects, and modify surface objects.

To create surface objects, you can:

- Use one of the 3D primitive tools to quickly create a basic shape. The 3D primitive tools create cubes, cones, and spheres.
- Use 3D geometry tools to generate 3D objects from existing profiles. With the 3D geometry tools you can extrude, lathe, sweep, skin, and cross-section profiles.

Using different 3D geometry tools, you can create various shapes from the same profile.

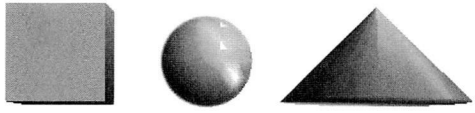


The profile on the left was lathed to create the surface object in the center. The same profile was extruded to create the surface object on the right.

You can also create very similar surface objects using a variety of different 3D geometry tools. For example, you can create a cylinder by skinning a circle, sweeping a circle along a path, extruding a circle, or lathing a polyline. All of these techniques are discussed later in this section.

Creating basic shapes with the 3D primitive tools

Use the 3D primitive tools to create a sphere, cube, or cone. Any of these objects can be created by drawing profiles and using 3D geometry tools, but this is the easiest way to create these basic shapes.



To create a sphere, cube, or cone:

- Select one of the 3D primitive tools and click in the workspace. The shape is created using the default dimensions. You can drag in the workspace to control the size of the object, or type different dimensions in the tool space.

  Once the object is created, you can open it, simplify it, and edit it like any other 3D object.

Extruding objects

Extrusion creates depth by extending the profile out perpendicular to the profile. There are two extrude tools:

Use the standard extrude tool to create objects whose sides are perpendicular to the profile.

Use the bevel extrude tool to create a beveled edge on the extruded object. This is especially useful for creating 3D text characters with rounded edges.

These characters were created using the extrude tool.

These characters were created using the bevel extrude tool.

To extrude a profile:

1 **Select the extrude tool or the bevel extrude tool.**

2 **Select the profile(s) you want to extrude.**

3 **Define the depth of the extrusion by dragging a line or clicking two points anywhere in the workspace.**
Alternatively you can type the extrusion depth and the bevel width for a bevel extrude in the tool space and press Enter. (You can set a bevel width only through the tool space.)

Select a profile.

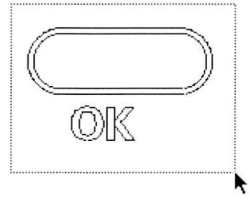
Select the extrude tool and drag a line.

Extreme 3D extrudes the profile, creating a surface object.

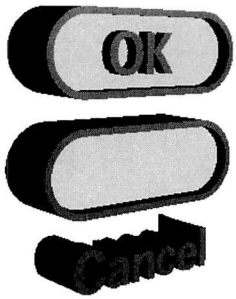
Rotate the object to better see the effect.

Tips for extruding

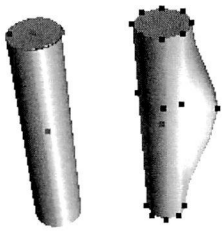
- The extrude tool is a simple and quick 3D geometry tool to use, since you only have to design the cross-section and define the extrusion depth. Straight-sided objects—long sticklike objects like cylinders or flat ones like gears or jigsaw puzzle pieces—are good candidates for extrusion.
- If a profile is completely enclosed by another profile in a selection, the extrusion will form a hole within the 3D object.
- You can drag a marquee completely around a group of objects to select all of them. Any child profile objects that are selected will also be extruded.



- Use the tool space to set the extrusion depth when you want to create many similar objects. For the buttons in the following figure, the border and letters are extruded 0.5 units, and the background is extruded 0.4 units. The border and background can be duplicated and used for multiple buttons. Additional text will always be extruded to the height of the border.



- To create a button that is dimmed, extrude the text only to the height of the background and apply a different material. For information on applying materials, see Chapter Five, "Lighting and Materials," or the Reference section of the Extreme 3D Help system.
- If you specify a positive bevel width value in the tool space, Extreme 3D applies the bevel outside the object; a negative value applies the bevel inside the object. The default bevel width is .05 units.
- You can double-click the bevel extrude tool in the tool palette to open the Bevel Preferences dialog box. You can specify whether you want to bevel the back, front, or both ends of the object. You can also specify that the bevel be sharpened to produce a hard edge or rounded for a softer edge. For more information on bevel preferences, see the Reference section of the Extreme 3D Help system.
- Extruded objects have control points only at their ends. To reshape the form in between, use the control point tool to add more control points.



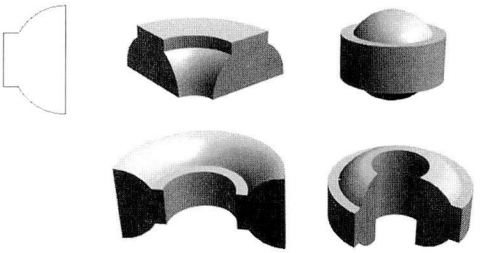
Control points have been added to the cylinder on the right so that it could be reshaped.

- The ends of extruded objects are flat. They are capped when Cap Ends is selected in the Preferences dialog box; otherwise they are open. To add control points to a cap surface, you must first separate the object's end caps. (Choose Separate End Caps from the Object menu.)
- The length of an extruded object is always the z-axis of the object, so when you use the deformation tools on an extruded object, select Deform Along the Object's Z-axis in the Deformation Preferences dialog box.
- When extruding holes, make sure that the inner object is completely enclosed by the outer object. Extruding overlapping objects may produce undesirable results.

Lathing objects

Use the ***lathe*** tool to rotate a profile around a defined axis.

You lathe an object by specifying an axis around which to rotate the profile and the number of degrees in the rotation—360 degrees lathes completely around the axis.



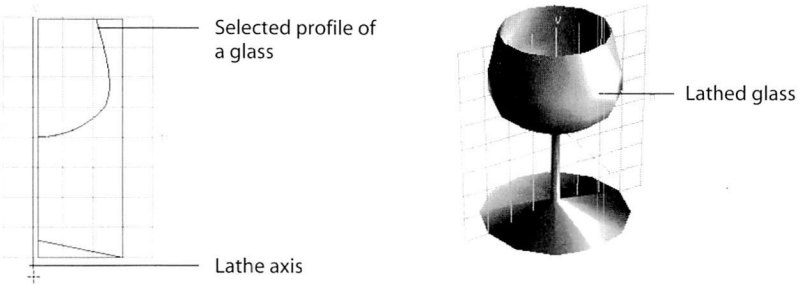
The figure shows how a single profile can be lathed into different 3D objects. The profile in the upper left corner was lathed around different axes with different degrees in the rotations for different results.

To lathe a profile:

1 **Select the lathe tool, then select the profile(s) you want to lathe.**
You can also drag a marquee completely around a group of objects to select all of them. Any child profiles that are selected will also be lathed.

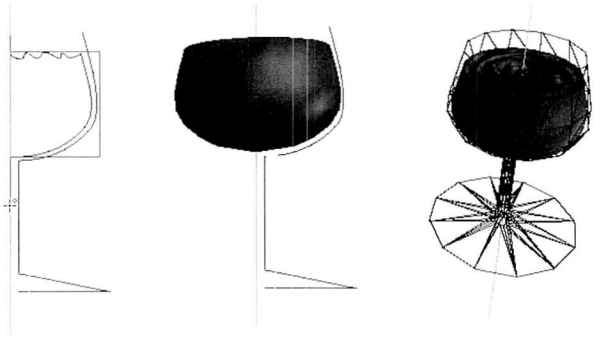
2 **Type a lathe angle in the tool space, or use the default angle.**

3 **Define the axis around which the profile will by lathed by clicking two points in the workspace or dragging a line in the workspace.**
Extreme 3D lathes the selected profile around the specified axis.



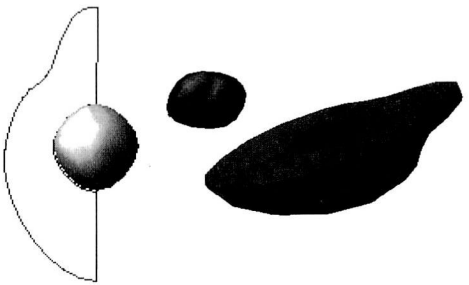
Lathing objects inside of objects

You can duplicate profiles or parts of profiles to parts that fit together, and lathe them either separately or at the same time.



Parts of this profile were duplicated and lathed separately to create the liquid in the glass. A construction line was used as a reference for the lathe axis so the glass and the liquid share the same center.

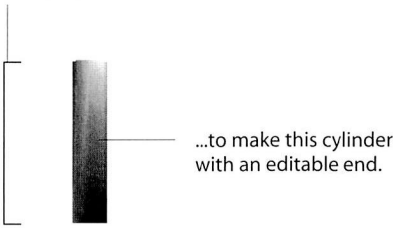
Lathing parts of profiles separately gives you control over individual components of an object.



Parts of these profiles were duplicated and lathed separately to create the pit in the avocado.

Tips for lathing

- Lathe objects are ***objects of rotation***—they are inherently circular, although they may be lathed through only a portion of the circle.
- If you lathe an object from the front view, the object's lengthwise axis is the y-axis.
- Although open-ended lathe objects are capped, it is possible to create lathe objects with editable end surfaces by drawing the profile all the way to the lathe axis.

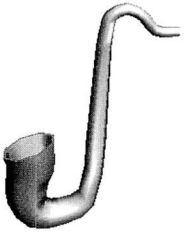


- To create a lathed object that has depth, create a double outline.

Sweeping objects

Use the ***sweep*** tool to specify a path along which to extrude a profile. Sweeping is similar to standard extrusion, except that you can use a path to create more complex shapes that twist and bend instead of extruding a profile along a straight line.

There are several options you can use when sweeping to control the exact shape of the object. The following sections demonstrate the ways you can control a swept object.

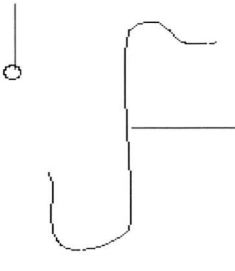


Creating a simple swept object

To sweep a 3D object:

1 **Draw the profile (the shape that will be swept).**

2 **Draw the path along which you want to sweep the profile.**
You can specify a path with any type of profile—lines, splines, arcs, circles, and so on.

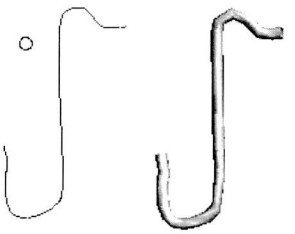


3 **If Cap Ends are selected in the Preferences dialog box, turn them off.**
For this object, a saxophone, you want to create an open tube.

4 **Select the sweep tool.**

5 **Select the object you want to sweep—the profile.**

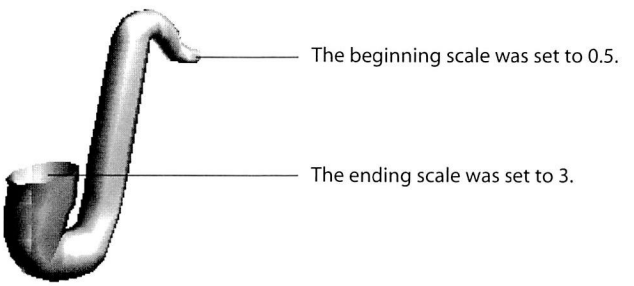
6 **Select the path.**
Extreme 3D builds the object, sweeping the profile along the specified path.



In this case, the circle is swept over the path, creating the basic shape of the saxophone.

Scaling the swept object

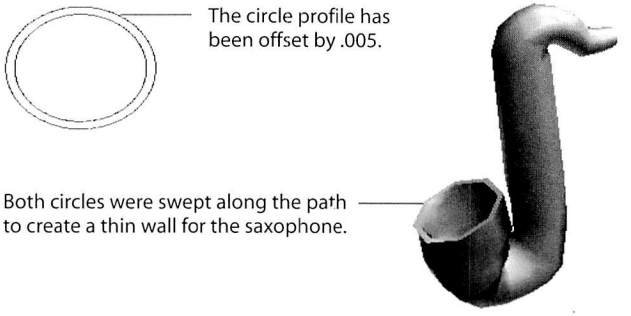
You can type a beginning and ending scale in the tool space to modify the appearance of a swept object, either tapering it or expanding it as it's swept along the path.



Sweeping a hollow object

Instead of relying on the Cap Ends option, you can control the thickness of the wall of the tube by creating two profiles, one inside the other. When Extreme 3D sweeps them over the path, it creates a hole automatically.

Use the offset tool to create a duplicate of the profile that is placed slightly outside of the original, in the center. This guarantees that the thickness of the wall will be consistent throughout.



Creating smoother curves

Double-click the sweep tool to open the Sweep Tool Preferences dialog box. The Sweep Tool Preferences dialog box lets you control the number of segments between control points. A larger number of cross-sections makes the swept object smoother, but it requires more time and memory to build the object. For more information on setting sweep tool preferences, see the Reference section of the Extreme 3D Help system.

Editing a swept object

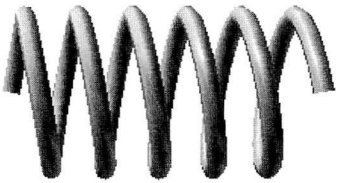
When you open a swept object for editing, you have the option of modifying the path, the profile, or both.

- Editing the profile modifies the shape of the object's circumference.
- Editing the path modifies the shape along which the profile is swept.

In addition, you can edit a swept object at different geometry levels to give different kinds of control over its shape. For more information, see "Changing geometry levels" on page 200.

Tips for sweeping

- Objects whose cross-sections vary only in size are good candidates for the sweep tool, especially if they have bends along their length. Although you can easily put a single bend into an extruded object with the bend deformation tool, it would be difficult to duplicate the sweep along the spline path shown in the following figure.



- Like extruded objects, swept objects can be capped.
- To control which way the cross-section is oriented along the sweep path, position it at the beginning of the sweep in the correct orientation.
- The z-axis of a cross-section for a swept object lies parallel to the path. Therefore, to change the direction that an irregular cross-section points before you sweep the object, change the cross-section's z orientation value in the Objects browser.

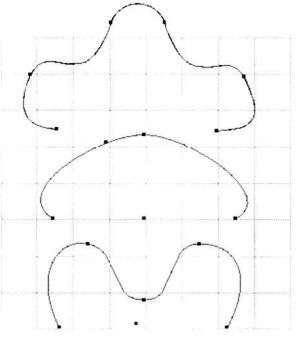
Skinning objects

Use the skin tool to stretch a surface over a series of profile ribs. Skinning is a good way to model aircraft bodies, topological data, or human figures. You can skin a path, such as a spline or polyline, or closed shapes, including rectangles, splines, polylines, and ellipses. You always need more than one profile to create a skinned object.

Skinning works most predictably on profiles that have the same number of control points. For best results, create a single profile, then duplicate the profile and adjust the copies' outlines to create ribs. Use construction lines and grids to help distribute the ribs in the workspace. However, you can create interesting shapes, such as organic forms, by skinning profiles that have different numbers of control points.

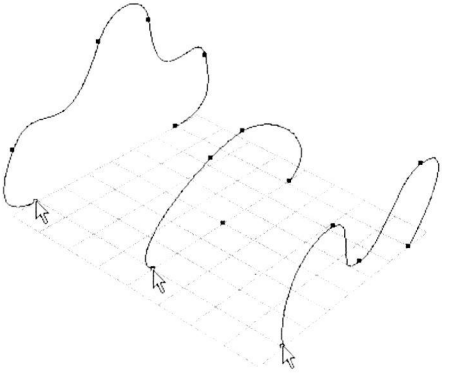
To create a skinned 3D object:

1 **Draw a series of profiles and arrange them to define a frame for skinning.**



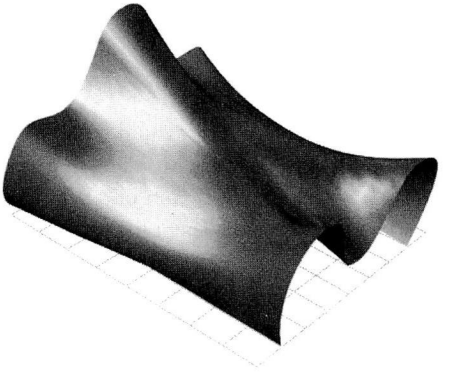
2 **Select the skin tool.**

3 **Select the profiles over which you want to stretch the skin.**
You might need to move or rotate the working plane so that the profiles are in the position and orientation you want the final object to be.



4 **When you have selected all the profiles, double-click in the workspace or press Enter.**

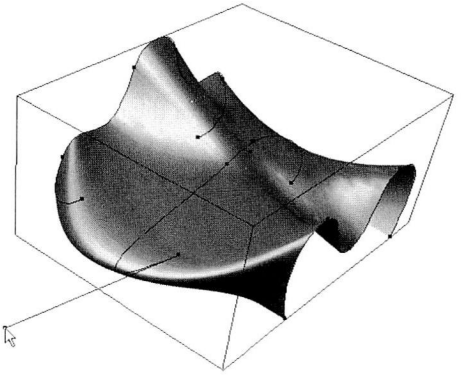
Extreme 3D builds the object, applying a skin over the frame of selected profile objects.



Note: If control points on the selected objects do not correspond to each other, and Auto Profile Direction is not active, the skinned object might be distorted. For more information on setting Auto Profile Direction, see "Setting skin tool preferences" on page 178.

Editing a skinned object

When you open a skinned object for editing, you can modify each profile rib. The following figure illustrates a skinned object open for editing.



When a skinned object is open for editing, you can see the profiles that define the ribs of the object. The shape of this skin object is being edited by dragging a control point.

Setting skin tool preferences

Double-click the skin tool to open the Skin Tool Preferences dialog box. You can set preferences that affect the appearance of skinned objects. For information on setting skin tool preferences, see the Reference section of the Extreme 3D Help system.

Tips for skinning

- The skin tool creates objects that would be impossible with any other tool: objects whose cross-sections vary in shape, in number of control points, and even in size along their length. If your object is organic in form, consider using the skin tool to create it. Time spent on setting up the skin operation can give very good results because the arrangement and order of the profiles is important.
- Use construction grids or relocate the working plane to arrange the skin profiles so they march along the length of the object.
- Link skin profiles together in order, so the parent object is the first profile in the skin, its child is the second, *its* child the third, and so on. This ensures the order in which the profiles are skinned, and lets you edit the position and orientation of each profile relative to its parent object in the Objects browser.
- The skin tool is useful for creating single-surface objects. Try skinning a pair of parallel lines, then simplify geometry and add a control point to the center. You now have a flat sheet that you can pull into a mountain.
- Skin objects take their orientation from the orientation of the first profile.
- To create accurate spline curves to use as profiles for skinning, use the polyline tool. Position all of the control points, then use the Smooth Polylines command on the Object menu to turn the polyline profile into a spline.

- When smoothing polylines to create a series of sequential spline profiles as lofting for skin objects, make a duplicate of the polyline at each stage before smoothing. Use the duplicate as the starting place for the next profile in the sequence. Duplicate the original profile and work with the duplicate, adjusting as you go.
- Extreme 3D maps control points on one profile to points on the next based on the location of the start and end points. When these points are lined up correctly, the rest will fall into place. Here are some tips for maintaining control over profile control points.
  - Consider maintaining the same number of control points on each successive profile to avoid unexpected results. You can add or remove control points as necessary to set up the right correspondence between successive profiles.
  - If your design demands different numbers of control points on successive profiles (if you're skinning a lofted object such as a bone, for example), skin a few profiles to test for twisting or other problems. If you find problems, you can make a new start point at the right spot: using the trim tool, press F3 (Windows) or Option (Macintosh) and click a point on the profile to break the object at that spot without removing any part of it. Shift-select the pieces and join them. This creates a new start point where you clicked.
  - Remember that each time you cut or fillet and rejoin the profile, the start and end points of the profiles may be changed.
- It's sometimes tricky to draw free-form splines using the 2D snap function to determine where your control points and tangent lines go. An easier way to draw curves is to set up dimensions of the curve by laying out construction lines and points to determine the general shape of the curve with the working plane on. Then turn the working plane off and use the construction lines and points to help guide in drawing the curve. You can also:
  - Turn the working plane off and draw the curves without any constraints.
  - Set the grid divisions to a low number so that working plane and construction grids have wider spacing and allow more flexibility in where geometry—a control point, for example—will snap.

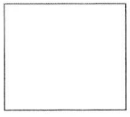
Creating objects from cross-sections

Use the cross-section tool to generate surfaces from a pair of profiles that represent the front profile and a cross-section view of an object. In an operation that is a cross between lathing and skinning, Extreme 3D stretches the cross-section over the front profile.

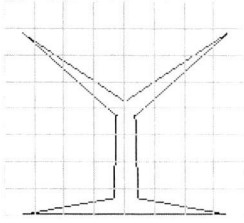
When the 3D object is created, the front profile maintains its shape, while the cross-section might be stretched to conform to the dimensions of the front profile.

To generate a 3D object from a cross-section:

1 **Draw the cross-section and front profile of the final 3D object.**



Cross-section

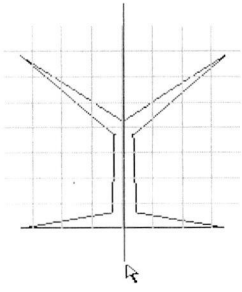


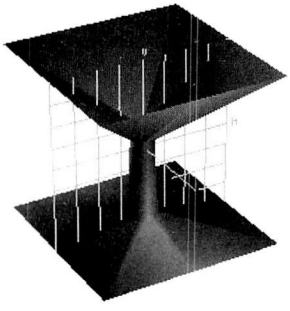
Front profile

2 **Select the cross-section tool, then click the cross-section.**

3 **Click the front profile of the 3D object.**

4 **Press F3 (Windows) or Option (Macintosh) and drag to specify the axis.**
Extreme 3D builds the object, deforming the cross-section profile to conform to the shape of the front profile.



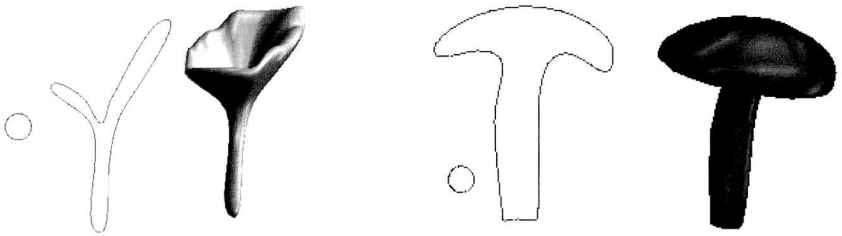


Cross-section examples

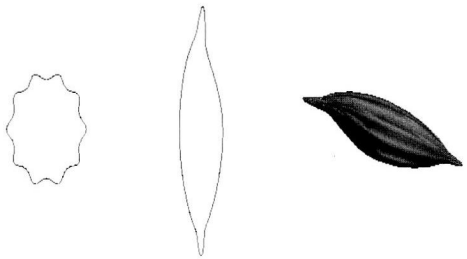
The cross-section tool is useful for creating both industrial and organic types of objects. Some objects that you can create with the cross-section tool can also be easily created with other tools, so it is a matter of which approach is easier for you or works better for your overall goal for the model.

These organic forms shown in the following three figures were created using the cross-section tool with the profiles on the right.

Asymmetrical front profiles can create interesting organic forms.



You can get results with the cross-section tool that are difficult or impossible with other techniques. For example, using a cross-section like the one in the following figure creates an object on which you otherwise would have to precisely edit geometry.



Modeling with metaforms

The *metaforms* tool creates blobs from defining profiles. The blobs have an attraction for one another that allow them to flow together and break apart when you move their defining profiles. This quality makes modeling with metaforms similar to modeling with clay.

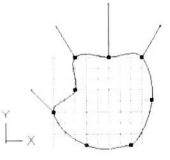
Creating metaforms

Like other Extreme 3D objects, metaforms are created from profiles. The defining profiles of a metaform object function, in some ways, like the metaform's skeleton. Each profile's sphere of attraction for other profiles in the metaform—blob radius—and magnitude of attraction for—blobbiness—make metaforms useful for making organic and curvilinear objects.

To create a metaform object with default Blobbiness and Blob Radius values:

1 **Use any of the profile tools to create the defining profiles for the metaform.** Closed profiles such as circles and squares create lozenge-shaped blobs; construction points create spherical blobs; lines, polylines, and splines create tubular blobs.

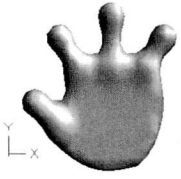
2 **Arrange the profiles in relation to one another to define the metaform shape.** The profiles' relation to one another defines the metaform's shape. Each profile defines a center around which the metaform blobs. Once the metaform is created, you can manipulate each control point and influence the blobbiness of the whole metaform object. Depending on the structural use you have in mind for each profile, you might want to simplify some or all of the profiles before creating the metaform.



3 **Select all the profiles in the workspace.**

4 **Choose the Metaforms tool.**

5 **A dialog box appears, letting you choose whether to Create the metaform or deselect the profiles. Choose Create.**
This creates a metaform object with default Blobbiness and Blob Radius values. Once the metaform is created, you can define these values on a per-profile basis.



Tip: At any time while the metaform is redrawing in the workspace press ESC or F11 (Windows) or Command-. (Macintosh) to interrupt the redraw and display the metaform's defining geometry.

By using the tool space, you can define the Blobbiness and Blob Radius values for the metaform before you create it.

To define the Blobbiness and Blob Radius values for a metaform as you create it:

1 **Use any of the profile tools to create the defining profiles for the metaform and arrange them in relation to one another to define the metaform shape.**

2 **Choose the metaform tool and tab to the tool space.**

3 **Edit the Blob Radius and Blobbiness values.**
This changes the sphere and magnitude of attractiveness of the profiles.

4 **In the workspace, click on each profile you want included in the metaform shape and double-click to create the metaform.**

Note: Metaforms cannot be deformed or trimmed. Metaforms can be simplified; however, once simplified, they become polylist objects, lose their defining geometry, and can no longer be edited or used as metaforms.

Editing metaforms

Once the metaform shape is made, you can edit its control points and its defining profiles to change its shape further.

To edit the control points of a metaform:

- Double-click the metaform to open its geometry. The control points of its defining geometry are visible. You can edit these control points in any of the ways you edit any other control point. For more information, see "Editing control points" on page 202.

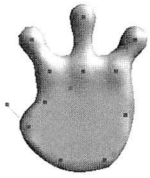
Fine-tune the metaform's shape further by editing its defining profiles. In addition to reorienting and repositioning the defining profiles of a metaform, you can edit their individual blobbiness and blob radius factors.

To edit the defining geometry of a metaform:

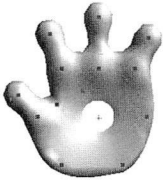
1. **Select the metaform in the workspace.**
2. **Open the metaform's geometry by double-clicking it or select it and choose Open Geometry from the Object menu.**
3. **Choose Render style from the Object menu, then choose Bounding Box, Wireframe, or Fast Wireframe.**
   This exposes the control points and the defining profiles of the metaform.
4. **Select any one of the defining profiles.**
   Once a profile is selected, you can reposition or reorient it just as you would any other profile.
5. **To edit the profile's blobbiness and blob radius properties, choose Objects from the Window menu to open the Objects browser, then choose the Metaform page.**
   - Edit the Blob Radius for each individual profile. Blob Radius is in world units and defines the profile's sphere of attraction. If one profile in the metaform is within the blob radius of another, the blobs defined by profiles are attracted to each other.
   - Edit Blobbiness for each individual profile. Blobbiness defines the profile's magnitude of attraction.
   - Check or uncheck the Active check box to make a given profile an active or inactive part of the metaform calculation.
   - Check the Negative check box to make the profile's Blob Radius and Blobbiness values exert a negative effect on the metaform shape. Use this feature to hollow out areas of the metaform.

- For closed profiles, such as circles, squares, and ellipses, check or uncheck the Fill check box to specify lozenge-like blobs or tubular blobs.

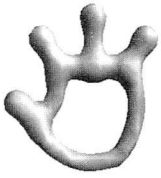
The blobbiness and blob radius values are increased for all profiles.



The thumb profile has the Active property unchecked.



The construction point in the center of the palm has the Negative property checked.



The closed spline profile that defines the palm has the Fill Property unchecked.

Note: You can also use the F3 (Windows) or Option (Macintosh) key to make a profile have a negative effect on the metaform. To do so, press the modifier key as you click the profile to add it to the metaform object.

You might decide, during the editing process, that you need to add another profile to the metaform to achieve the look you want.

To add a profile to the metaform object after it has been created:

1. **Create the new profile and deselect it.**
2. **Choose the metaform tool from the tool palette.**
3. **In the workspace, select the profile you want to add to the metaform object.**
   Click to add additional profiles.
4. **Click the metaform object you want to add the profile to.**
   The profile is added to the metaform object.

   By default, the metaform shape updates whenever you edit it. Turning this feature off speeds up the editing process.

To turn Update on Edit off:

1 **Select the metaform object in the workspace.**

2 **Open the Objects browser by selecting Objects from the Window menu.**

3 **Select the Metaform page and uncheck the Update on Edit check box.**

Modeling using particle systems

The particle system tool creates a collection of shapes or polygons that evolve over time. Although particle systems are typically used to simulate dynamic phenomena such as smoke, water, or fire, you can also use particle systems to model complex shapes such as dandelion seeds or trees.

To create a particle system:

1 **Using any of the modeling tools, create the shape you want each particle in the system to have.**
All particles in the particle system have the same shape. To create a particle system that has particles of different shapes, create more than one particle system. To generate small single polygon particles at render time, use a construction object or profile as the initial shape. To generate larger single polygon particles, lathe a line. The leaves in the tree model described later are created by extruding the spline profile of a leaf shape.

2 **Select the particle system tool from the tool palette.**

3 **In the workspace, select the shape you created to use as the particle shape.**

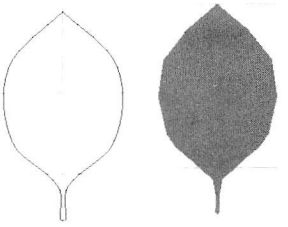
4 **Define the particle system's initial position by clicking in the workspace.**
The new particle system assumes this position and inherits its particle size from the scale of the original object. The original object can be deleted or used as a separate object in the scene. It is no longer related to the particle system object.

Note: To change the polygon resolution of polygons in a particle system, edit the smoothing settings of the original shape before you use it to define the shapes in a particle system.

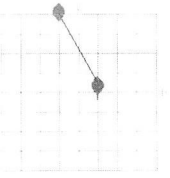
Once you have created the particle system, you can use it to create a complex model. The recipe for the tree model, below, demonstrates how to use a particle system to create a model by evolving it into the desired state, then simplifying it. For more information about the particle system's properties and how they relate to one another, see "Animating particle systems" in Chapter Four.

To create leaves of a tree from a particle system:

1 **Create a leaf by drawing a spline outline of a leaf and extruding it.**



2 **Follow the steps for creating a particle system using the extruded leaf as the shape for all particles.**



3 **Select the leaf particle system in the workspace and open the Objects browser by choosing Objects from the Window menu.**

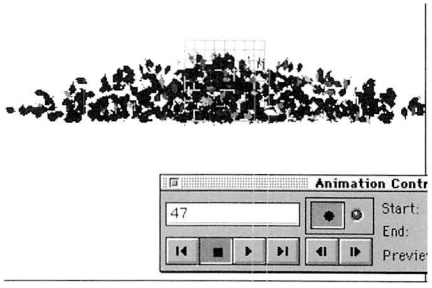
4 **Choose the Particle pages in the Objects browser and set the following properties to the values indicated. Leave other properties at their default values.**

- Set the Particle Rate to 500. This increases the number leaves on the tree to 500.
- Set Source Radius to 4.0. This enlarges the area that the leaf particles emanate from.
- Set the Cone Angle to 160. This determines how much the leaves fan out from their original position.
- Set the Particle Lifespan to 3 seconds. This keeps each leaf in the particle system animating for three seconds before disappearing.
- Set the Angular Velocity to 180. This makes the leaves roll as they animate so they don't all face the same direction.

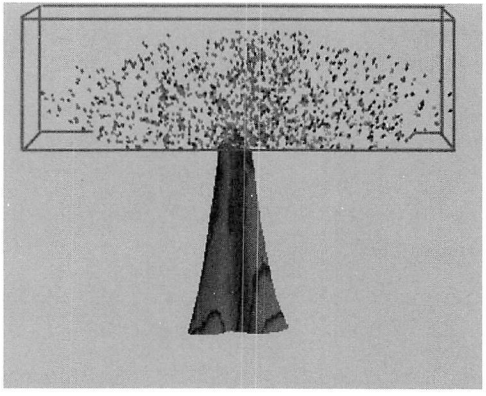
5 **Choose Animation Controls from the Animate menu and set the Current Frame to 90 frames or 3.00 seconds.**

6 **Click Play on the animation controls to play the animation.**

7 **When the particle system achieves the look you want, click Stop on the Animation Controls.**

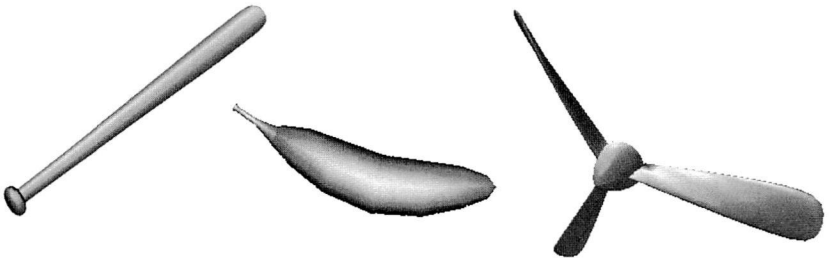


8 **With the particle system still selected in the workspace, choose Simplify Geometry from the Object menu.**
The particle system is converted from a particle system to a polylist object with no tracks. Move any of the leaves to move the entire polylist.



Deforming surface objects

The deformation tools twist, bend, taper, stretch, or skew the shapes of existing 3D objects as if they were made of clay. With the deformation tools, you can customize shapes without having to edit individual points in an object or to create multiple objects and fit them together.



The baseball bat was created with the stretch and taper tools. The banana was created with the stretch and bend tools. The propeller was created with the stretch, taper, and twist tools.

The deformation tools are shown below.

Twist tool

Bend tool

Taper tool

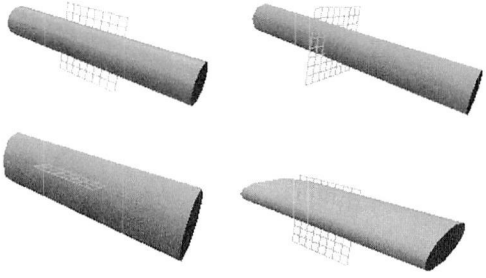
Stretch tool

Skew tool

Note: You can use the deformation tools only on objects whose geometry level has been simplified.

Double-click any of the deformation tools to open the Deformation Tool Preferences dialog box. You can specify one of three object axes (or the working planes's z-axis) along which to deform the object. The preferences apply to all deformation tools. For more information, see the Reference section of the Extreme 3D Help system.

You can perform custom deformations by adjusting the working plane to the desired orientation, then specifying the deformation along the z-axis of the working plane.

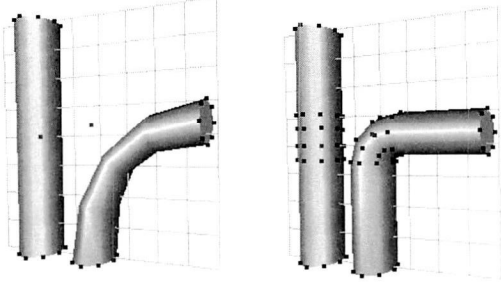


When you choose the Working Plane's Z Axis preference, you can change the deformation by changing the position and orientation of the working plane.

You can limit a deformation to a specified segment of an object. Use this technique to create complicated objects using few operations.

Both stretch objects were created from the knob in the upper left corner of this illustration. For the center object, a limited stretch was applied, which excluded the knob itself. For the object on the bottom, the stretch was applied along the object's entire length.

Extreme 3D uses control points to deform an object. You might need to add control points to achieve a smoother deformation.



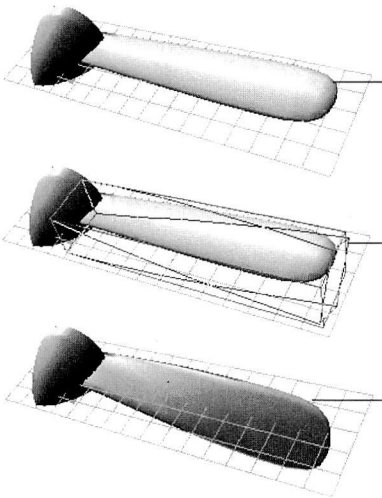
The bar that contains additional control points defining the area of the bend displays a cleaner, more well-defined bend.

Twisting objects

The twist tool twists the shape of an object around the axis specified in the Deformation Tool Preferences dialog box. The default is the z-axis of the object.

To twist an object:

1. **Select the twist tool.**
2. **Select the object(s) you want to twist.**
   If the selected object does not have its geometry simplified, a dialog box prompts you to simplify the object or deselect it.
3. **Drag to twist the object around the specified axis, or enter a twist angle in the tool space and press Enter.**
   As you drag, the object's bounding box twists to indicate the object's new form.



The propeller blade before the twist deformation.

The bounding box shows the twist in progress.

The blade shows the result of the twist.

Note: To twist an object only along a portion of its axis, press F3 (Windows) or Option (Macintosh) and click the starting and ending points of the twist.

Bending objects

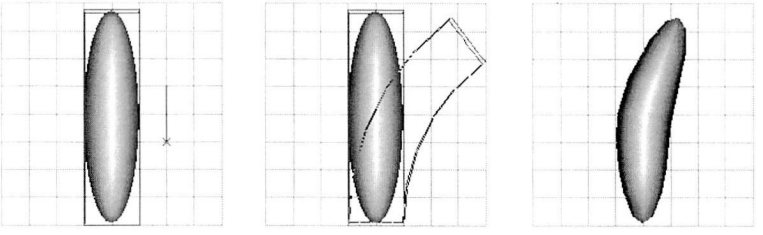
The bend tool bends the shape of an object along the axis specified in the Deformation Tool Preferences dialog box. The default is the z-axis of the object.

To bend an object:

1 **Select the bend tool.**

2 **Select the object(s) you want to bend.**
If the selected object does not have its geometry simplified, a dialog box prompts you to simplify the object or deselect it.

3 **Drag to bend the object along the specified axis, or enter a bend angle in the tool space and press Enter.**
As you drag, the object's bounding box bends to indicate the object's new form.



Tapering objects

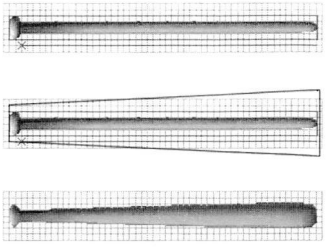
The taper tool tapers or flares the shape of an object along the axis specified in the Deformation Tool Preferences dialog box. The default is the z-axis of the object. Set the scale of the taper in the tool space.

To taper an object:

1 **Select the taper tool.**

2 **Select the object(s) you want to taper.**
If you select an object that does not have its geometry simplified, a dialog box appears that prompts you to simplify the object or deselect it.

3 **Drag to taper the object around the specified axis, or enter a taper amount in the tool space and press Enter.**
Drag the object up to taper it, or down to flare it. As you drag, the object's bounding box indicates the object's new form.



The baseball bat was created by defining an anchor point on the object's axis, then using the taper tool to apply a limited taper to the remainder of the object.

Stretching objects

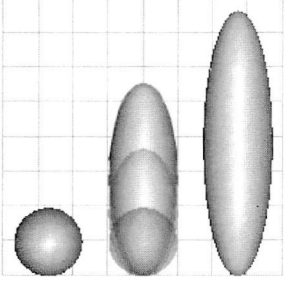
The stretch tool extends or collapses the shape of an object along the axis specified in the Deformation Tool Preferences dialog box. The default is the z-axis of the object. Set the stretching factor in the tool space.

To stretch an object:

1 **Select the stretch tool.**

2 **Select the object(s) you want to stretch.**
If you select an object that does not have its geometry simplified, a dialog box appears that prompts you to simplify the object or deselect it.

3 **Drag to stretch the object along the specified axis, or enter a stretch amount in the tool space and press Enter.**
Drag the selected object down to stretch it, or up to collapse it.



Skewing objects

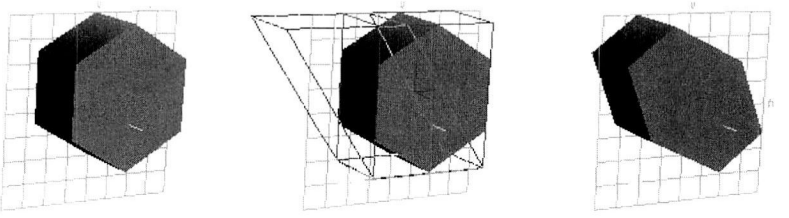
Use the skew tool to shift an object along a plane, as defined in the Deformation Tool Preferences dialog box.

Using this tool you can skew either the entire length or a selected section of an object.

To perform an unlimited skew:

1 **Select the skew tool and click the object.**

2 **Drag anywhere in the workspace.**
The object continues to skew as long as you drag.



When performing a limited skew, you must also define the beginning and end of the section to be skewed.

To perform a limited skew:

1 **Select the skew tool and click the object.**

2 **Press F3 (Windows) or Option (Macintosh) and click to define the starting and ending points of the skew.**

3 **Drag anywhere in the workspace.**
When you drag the object, the object skews between the two points. Tangents outside the section may move slightly to provide a smoother transition between the skewed and unskewed section of the object.

Modifying 3D shapes

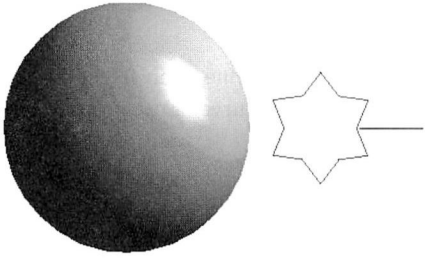
Using the projection, intersection, and 3D trim tools, you can cut away parts of 3D geometry. This lets you cut away holes in objects, or dissect pieces that were created as one object.

Projecting profiles onto 3D geometry

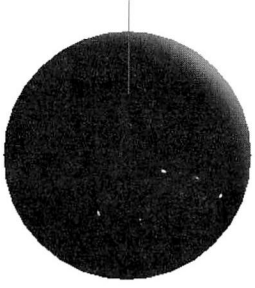
Using the Projection tool, you can project a 2D profile onto the front and back faces of a 3D object. Extreme 3D projects the profiles as trim curves. You can then use the 3D trim tool to cut away the projected image, leaving a hole in the shape of the original profile through the object.

To project a profile through an object:

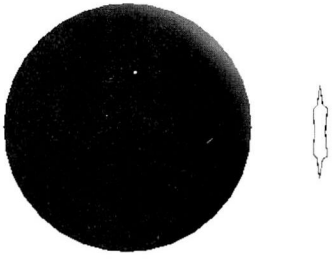
1 **Create the profile shape and 3D object.**



2 **Change your view to position the profile.**
Some views might make it difficult to determine whether the profile is positioned correctly. If you choose Left from the View menu, you can see the profile and move it to the object's front.

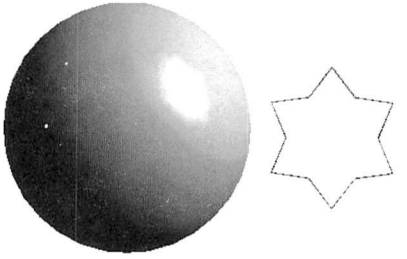


When you view from the left, you can see that the profile is not in front of the sphere.

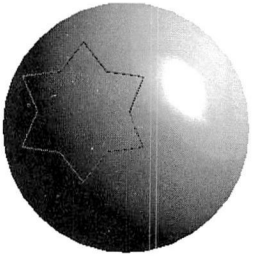


Use the Right arrow key to nudge the selected profile to the front of the sphere.

3 **Change your view and drag the profile in front of the 3D object you want to project onto.**
Choose Front from the View menu to change your view again and you can see the profile and the 3D object. Drag the profile to the position on the object where you want to project its shape.



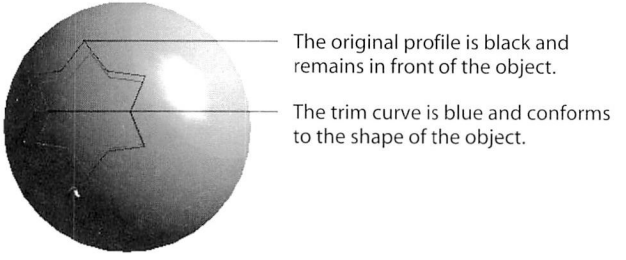
When you view from the front, you know the profile is in front of the sphere.



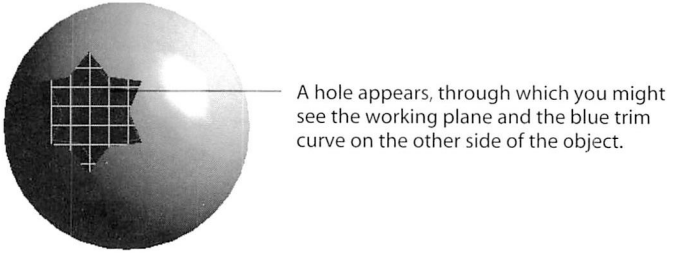
Position the profile where you want to project its shape onto the surface of the object.

4 **Select the projection tool.**

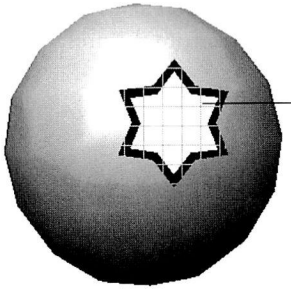
5 **Select the 2D projection profile, then select the target object.**
Extreme 3D places a trim curve of the projected image onto the front and back faces of the object.



6 **Select the 3D trim tool. Click the trim curve on the object, then click inside the trim curve.**
Extreme 3D trims the sphere in the shape of the profile.



7 **Optionally, you can rotate the object and use the 3D trim tool on the other trim curve.**



You can now see through the object, past the working plane and out the other side.

Note: You can trim the object either inside the trim curve or outside it but not on both sides.

Working with trim curves

Trim curves are a specialized type of polyline attached to a 3D object. Their main function is to define a shape to be trimmed. Trim curves are different from polylines in the following ways:

- You cannot move a trim curve.
- You cannot copy or duplicate a trim curve and then use it as a trim curve.
- You cannot edit the geometry of a trim curve.
- You cannot use the Smooth Polylines or Fit Polylines commands with a trim curve.
- Trim curves cannot be used on polylist, metaform, or particle system objects, or on unseparated end caps.
- If you simplify a trim curve, it becomes a polyline that can be moved, edited, or deleted like any other polyline, but it can no longer be used as trim curve.

Tip: You can adjust the fit of the trim curve to a surface by adjusting the tolerance setting in the Trim Preferences dialog box. For more information on setting trim preferences, see the Reference section of the Extreme 3D Help system.

To simplify a trim curve:

- Select the trim curve and choose Simplify from the Object menu.

Creating intersections

Use the intersection tool to draw trim curves at the points where two profiles or 3D objects intersect. You can then trim the profiles or objects.

To create an intersection:

1 **Place two objects so they intersect.**

2 **Choose the Intersection tool.**

3 **Click near the intersection points of the first object and then the second.**
Extreme 3D marks the intersection points with a blue trim curve.This is where the objects will be divided.

When showing the intersection of 3D objects, Extreme 3D highlights the area of intersection. For 2D profiles, one intersection point is placed closest to the selected area.

Trimming 3D objects

Use the 3D trim tool to remove parts of 3D objects that have been defined with the projection or intersection tools. After defining the area that will be trimmed, blue trim curves appear on the object.

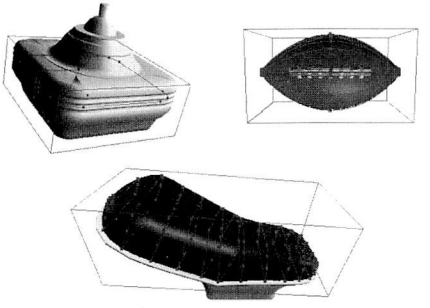
1 **Select the 3D trim tool.**

2 **Click the trim curve.**
The arrow pointer displays a hollow diamond when the mouse is directly over the trim curve.

3 **Click the area inside the trim curve that you want to trim.**
After you have selected the trim curve, the cursor becomes a matte knife cursor, reminding you that any surface you click next will be cut.

Editing 3D geometry

You can open and edit the geometry of any 3D object. When an object is opened, it displays control points that you can drag to change the shape of the object. The following figure shows some Extreme 3D objects opened for editing.



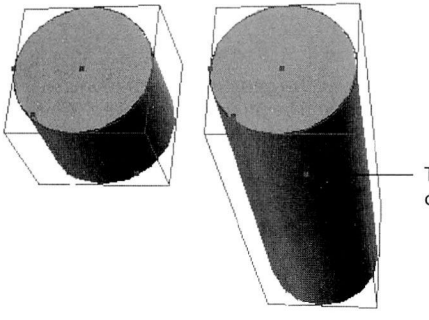
These objects have been opened for editing, displaying their defining geometry.

Note: When an object is opened for editing, its editable components are displayed in the Objects browser. You can use the browser to modify the open object.

To open an object for editing:

- Double-click the object with the arrow tool, or select it and choose Open Geometry from the Object menu.

An open 3D object displays control points for both the profile that defines the object and for the 3D operation that was performed on it. For example, a cylinder extruded from a circle and opened for editing displays control points for both the original circle profile and the depth of the extrusion.



The extrusion depth of this cylinder is being changed by dragging a control point.

To close an object's geometry:

- Double-click the object with the arrow tool, or select the object(s) you want to close and choose Close Geometry from the Object menu.

Changing geometry levels

Objects have different levels of geometry:

- **Defining geometry**—displays the object's underlying profiles or the settings of the modeling tool used to create the surface object. This geometry level provides the greatest amount of control over the object's entire shape.
- **Surface geometry**—displays the control points and tangent line endpoints of the surface spline-based matrix. This geometry level provides control over more localized areas of the surface.
- **Polymesh/polylist geometry**—displays control points which are the vertexes of polygons. Surface objects without holes that have been simplified twice expose polymesh geometry. Surface objects with holes that have been simplified twice expose polylist geometry. Vertex-level editing gives you precise control over a very small area of the surface object.

  Although polymesh and polylist geometry appear to be the same, they differ in two ways:

  - The polygons of a polymesh surface are always quadrilaterals; the polygons of polylist surfaces can have any number of sides.
  - The vertexes of adjacent polymesh polygons are always shared; the vertexes of adjacent polylist polygons are not necessarily shared.

To change an object's geometry level:

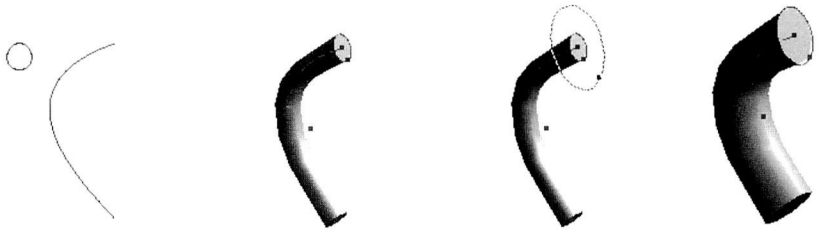
- Select the object or objects and choose Simplify Geometry from the Object menu.

Note: You can return to a previous level of geometry only through an undo operation. It's a good idea to duplicate an object before you begin simplifying or editing its geometry so that you can return to the original level of geometry.

Tip: Each time a level of geometry is removed from an object, information is discarded and Extreme 3D requires less memory to store information about the object. In general, editing a polymesh is faster than editing defining geometry, which is in turn faster than editing surface geometry.

Editing defining geometry

When editing defining geometry, you can modify the original profile and the settings of the 3D geometry tool used to create the object. For example, for a swept object, you can modify the size of the profile and shape of the sweep path.



The circle will be swept along the spline.

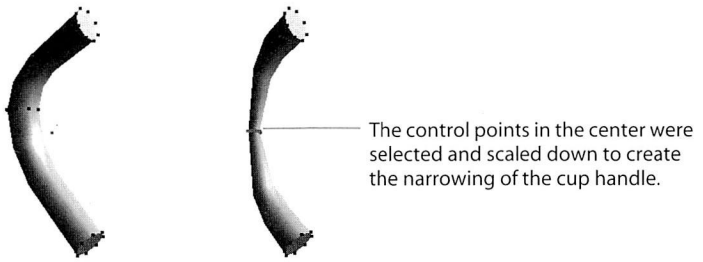
After sweeping, the defining geometry shows the circle and spline control points.

The radius of the circle profile is increased.

The 3D object changes to reflect the modified profile shape.

Editing surface geometry

When you've changed an object's geometry level to surface geometry (or if the profile in its defining geometry is a spline curve), you can modify its shape by dragging control points and the end points of tangent lines.

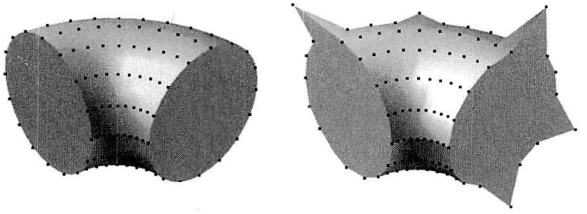


By holding a modifier key, you can drag control points and tangent lines to any position—just as you would a spline curve.

You can use the Arrow Tool Preferences dialog box to select the planes within which you can drag points on an object. Constraining these points to specific planes gives you increased control when creating objects that have one or more flat surfaces. For more information on setting preferences for moving points, see the Reference section of the Extreme 3D Help system.

Editing polymesh geometry

When an object's geometry level has been changed to polymesh geometry, you edit it by moving the vertexes of the mesh polygons, either by dragging or by entering values in the Objects browser. As with control points, you can select multiple vertexes and manipulate them as a group.



While dragging a vertex, press the appropriate modifier key to snap the point to other geometry in the workspace.

The number of polygons in the mesh is dynamic. By changing the Adaptive or Uniform Smoothing settings of an object, you can change its polygon resolution.

Tip: Use Uniform or Adaptive Smoothing to create models with various levels of detail for VRML or 3DMF export. Low final smoothing settings create objects that are optimized for real-time rendering.

Note: The surface geometry of 3D objects with holes simplifies to polylist instead of to polymesh geometry. You edit this type of geometry the same way—by dragging vertexes or entering values in the Objects browser.

Editing control points

The fundamental unit of any geometry level is the control point. Use the control point tool to add control points to any level of 3D geometry. You can also use the control point tool to remove existing control points from an object. For more information, see "Adding control points" on page 164.

Note: When you add or delete control points on surface objects or polymesh objects, Extreme 3D might add or delete other control points to maintain the geometric integrity of the object.

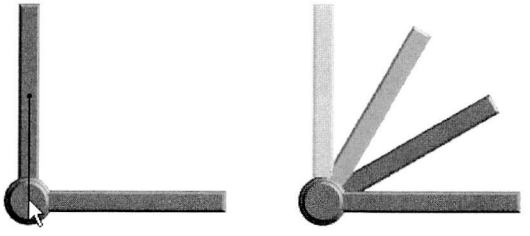
Keep these tips in mind when selecting and manipulating control points:

- Use the zoom tool to zoom in on the point you want to edit.
- Use the arrow keys to nudge control points. Open the Preferences dialog box and set the nudge position very small to make tiny, accurate adjustments.
- Drag a marquee around an area including several control points and move, scale, or rotate them together with the mouse or with the arrow keys.
- Use the B key to break the relationship of a control point's tangent lines to each other.
- Use the center point tool to move the center point relative to the control points you are going to edit. For example, if you want to taper a cylinder, move the control point to the bottom of the cylinder. Then taper the object by selecting the end points and scaling; the end points will move relative to the center point.
- Edit control points from the Objects browser. Although the browser shows the name of the whole object, if only one control point is selected, changes in the browser affect only that point.

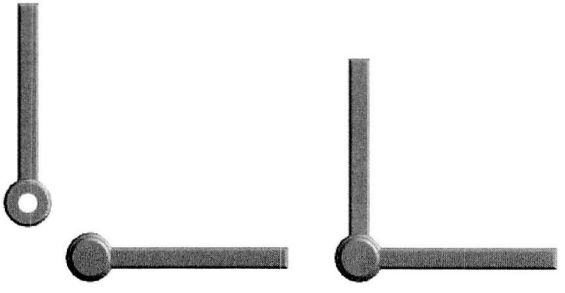
Repositioning an object center

Use the object center tool to reposition an object's ***center point***—the point around which the object rotates and to which the object's parent and children are aligned.

The center point appears when an object is open for editing. Because all objects rotate around their center point, this is an important tool for controlling the behavior of objects. For example, to create a hinge that actually swings, you could move the object center to the hinge's pivot point, then use the Objects browser to constrain rotation around the x-axis and z-axis.



In addition, alignment commands always align objects by their center points. By moving a center point, you can control how objects align.



To reposition an object's center:

1 **Open the object you want to modify.**
Extreme 3D displays the center point as a small green rectangle.

2 **Select the object center tool, then drag the object's center to the new location. (You can even drag the center point out of the object.)**
While dragging the center point, press the appropriate modifier key to snap the point to other geometry in the workspace.

Assembling models

To create complex models, you need to be able to create, manage, and assemble multiple objects. Extreme 3D provides a number of techniques to meet these needs. This section discusses:

- Linking objects
- Copying and duplicating objects
- Hiding and layering objects
- Using construction objects
- Aligning objects

Linking objects

When you define a link between two objects, one object becomes the parent and the other becomes the child. This relationship defines how the objects are positioned and oriented in the world, and how they move in relation to one another.

Linking objects in parent-child relationships makes it easier to manage complex models. For example, you can use linking to specify the propeller assembly of a boat as a submodel that can be viewed and manipulated separately from the rest of the model.

Linking also allows you to build models that exhibit realistic behavior. For example, you can link a propeller to a shaft in a boat model and specify that the propeller can rotate independently of the shaft.

By default, every new Extreme 3D object is a child of the Extreme 3D world—its position and orientation are defined relative to the world. When you link an object to another object, the linked object's position and orientation become relative to its parent object rather than to the world.

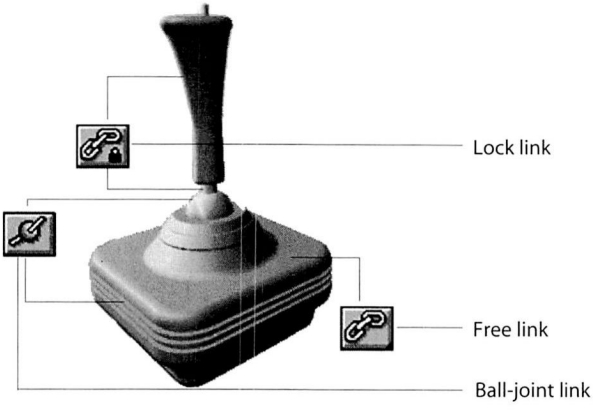
Parents can have any number of children, which in turn can have their own children. A child, however, can have only one parent. You can link profiles to 3D objects and vice versa.

Extreme 3D provides tools for creating four different types of links:

- The ***free link***, in which the child object can move independently of its parent, but moves when the parent moves. The child changes scale, orientation, and position in response to corresponding changes in the parent's scale, orientation, and position.

- The ***lock link***, in which the child object is bound to its parent, changing scale, orientation, and position in response to corresponding changes in the parent's scale, orientation, and position. Neither the parent nor the child object can move, rotate, or be scaled independently.

- The ***ball-joint link***, in which the child can rotate around its center point and be scaled independently of its parent, but cannot move independently of the parent.



The joystick handle is linked to the ball using a lock link; the ball is linked to the base using a ball-joint link; and the base is linked to the table top using a free link. This simulates the mechanical behavior of the joystick: the handle and shaft move together; the handle and shaft can rotate freely in the base; and the base can be moved independently of the table top.

The fourth type of link—the ***watch link***—creates a relationship in which the z-axis of the watcher stays oriented to the center of the target. When the target moves, the watcher rotates to orient its z-axis to the target's new position. Both target and watcher can move independently of one another. Watch links can co-exist with other types of links.

Tip: In addition to the constraints provided by the four link types, you can also constrain in any of six degrees of freedom by using the Objects browser to lock the attributes of the child object.

To set a link:

- Select the appropriate link tool, click the object that you want to specify as the child, and drag a line to the object that will be the parent. The link is set. When you release the mouse button, the parent object is selected, and all of its children are selected with gray bounding boxes.

Note: Child objects are selected in gray bounding boxes to help you locate their parent object (which is selected in red). This is especially handy when you work with objects that you haven't explicitly linked, such as text.

To break a link:

- Select the unlink tool and click the child object to unlink. The link to the parent object is broken. However, the newly unlinked object retains any links it has to its own children.

To view or break watch link relationships in your model, choose Watch Links from the Window menu. Watch links are particularly useful for animating the camera and lights to follow the action. For more information about using watch links in animation, see "Creating a watch-linked animation" in Chapter Four.

Tip: You can also unlink an object from its parent by using one of the other link tools to link the object to the world or to another object.

To move an object's children up one level in the link hierarchy, use the reparent tool. After reparenting, the children of the linked object have the same parent as the former parent object.

To reparent an object:

- Select the reparent tool and click the object to reparent.

Note: The reparent works on all types of links except watch links.

Copying and pasting objects

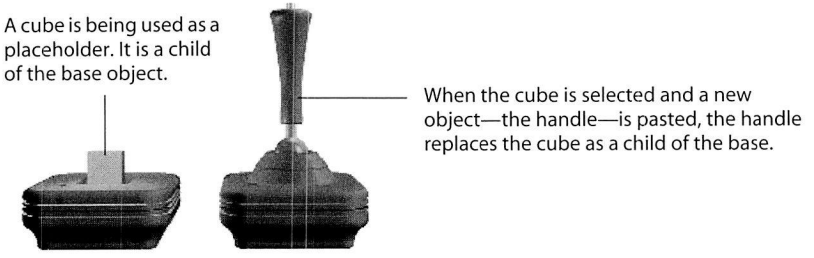
You can edit objects in the workspace using the standard Cut, Copy, and Paste commands.

You can also use these commands to perform a paste-replace. This replaces an existing selected object with another object from the Clipboard. When you paste-replace an object, it inherits the position, orientation, and link relationships of the object it replaces.

To perform a paste-replace:

- Cut or copy the object, then select the object that will be replaced and choose Paste from the Edit menu.

Using this technique, if you copy an object such as a handle, then select an object that is a child of a base and perform a paste-replace, the pasted object becomes a child of the base. For more information about object-parent and child-linked relationships, see "Linking objects" on page 205.



Note: If you paste one object into multiple selected objects, each original object is replaced with a copy of the pasted object.

When pasting an object, Extreme 3D retains the name of the original object for the copy.

Copying in the Objects browser

The Cut, Copy, and Paste operations work differently in the Objects browser than they do in the workspace.

When you paste an object in the Objects browser and a single object is selected in the browser, the pasted object does not replace the selected object as it does when you paste in the workspace. Instead, a new object is added that assumes the same level of hierarchy as the selected object. For example, if you copy an axle object that is a child of the world, then paste it into another object that is a child of an object called Frame, the pasted copy becomes a child of Frame while retaining its original position and orientation.

If you select and copy multiple objects in the workspace, then paste in the browser, copies of the objects appear in the locations of the selected objects.

Duplicating objects

There are a few different options you can use when making copies of objects in Extreme 3D. You can:

- Use the Duplicate command on the Edit menu to create exact copies of objects. Use the Duplicate Special command on the Object menu to create an array of objects.
- Use the 2D and 3D mirror tools to create mirror images of objects across a selected axis or plane.
- Use the Duplicate Links command to duplicate selected 3D geometry and its hierarchical links.

Duplicating in the workspace

To duplicate an object:

- Select the object you want to duplicate and choose Duplicate from the Edit menu. Extreme 3D creates an exact copy of the selected object, offsetting the duplicate object slightly.

Duplicating from the Objects browser

To duplicate an object from the Objects browser:

- Select the object you want to duplicate and press Control+D (Windows) or Command-D (Macintosh).

When an object is duplicated, any attributes of the object are also duplicated, including material attributes and links. If an object you duplicate is the parent of other objects, the child objects are also duplicated. If an object is the child of another object, its duplicate becomes a child of the same object. For more information, see the following section.

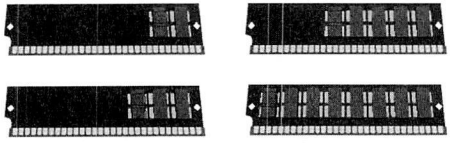
Duplicating with links

You can duplicate an object and its children using Duplicate with Link. Objects created this way inherit both the parent/child relationship of the original object and the relative position, orientation, and scale the original object had to its parent.

To duplicate a link:

- Select the object for which you want to duplicate a link, then choose Duplicate with Link from the Object menu. Extreme 3D creates an exact duplicate of the object and any of its children and makes the new object a child of the original object.

The object created from a Duplicate with Link operation inherits all the attributes of the original object, as well as any of its child objects. For example, if the parent object is scaled, its duplicate will be scaled relative to the original object.



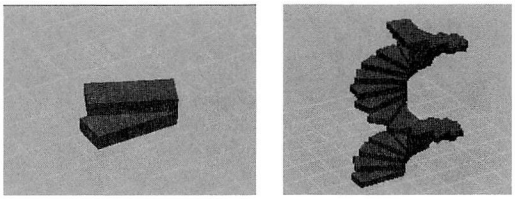
To build this model of a SIMM, each memory chip is added using the Duplicate with Link command. In each case, you're duplicating the link, including the object's relationship to the parent.

To make multiple duplicates of a parent and child:

1 **Select the child object for which you want to create multiple duplicate links, then choose Duplicate Special from the Object menu.**

2 **In the dialog box that opens, select Duplicate with Link.**

3 **Enter the number of duplicates you want to create in the Duplicate with Link text entry field and click OK.**
Extreme 3D creates as many duplicates of the child objects as you specify. Each new object is a child of the original parent and is positioned and orientated to the preceding child object in the same relative way as the original child is to the parent object.



Here two stairs—one a child of the other— are duplicated instantly to create a spiral staircase.

Duplicating an object to create an array

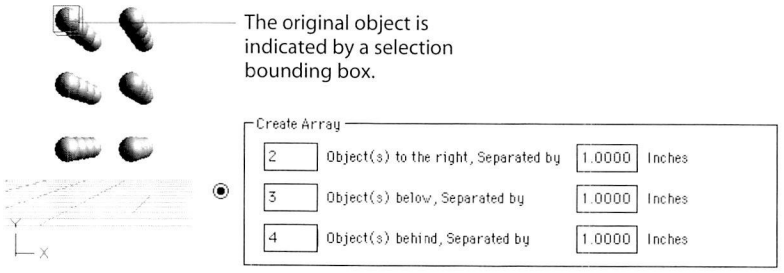
Create an array of objects by duplicating an existing object or objects. Extreme 3D makes as many copies of the object as you specify and arrays them to the right, below, or behind the original object at a spacing you define. Place duplicates to the left, above, and in front of the original object by specifying negative spacing values.

To create an array of objects by duplicating one or more objects:

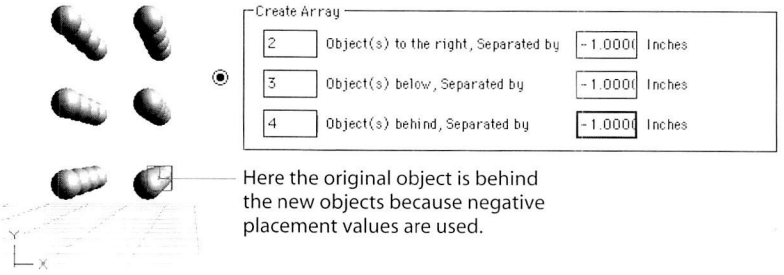
1. **Select the object or objects in the workspace that you want to duplicate and arrange in an array.**

2. **Choose Duplicate Special from the Object menu and select Create Array.**

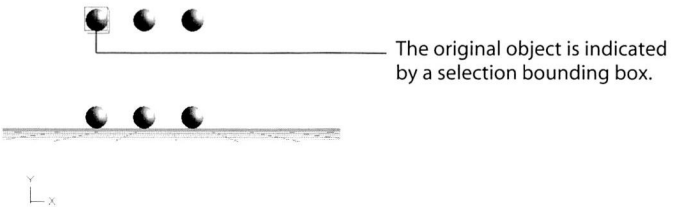
3. **Enter the total number of objects you want in each dimension in the three dimension fields.**
   An increment in the value of any dimension has a multiplier effect on the other dimensions. For example, specifying two objects to the right, three objects below and four objects behind results in twenty four total objects (2x3x4=24). The original object is included in the final array, so entering a value of 1 in any of the dimension fields does not create any duplicate objects in that dimension.



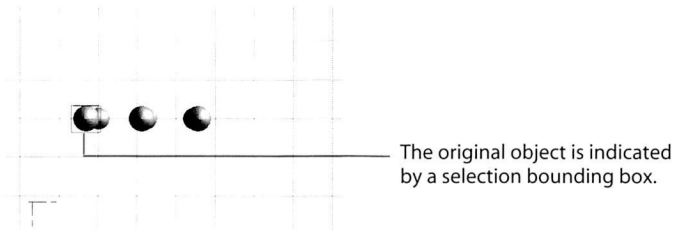
4. **In the units fields, enter the number of units you want between each object for all three dimensions.**
   Measurement defaults to the units you have set in the Units dialog box under the Object menu. Use negative spacing values to place duplicates to the left, above, or in front of the original.



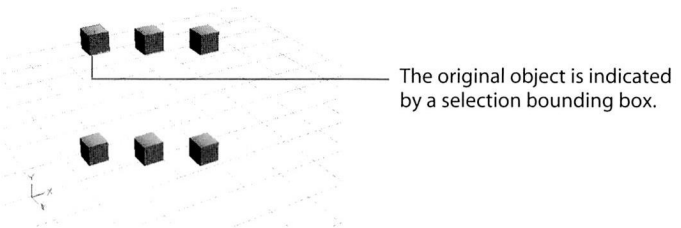
As with all other duplicate features in Extreme 3D, copies are placed in screen space, not world space, so your viewing angle affects the placement of objects.



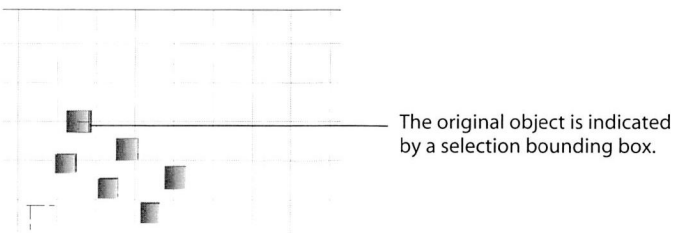
Here an array is created while the object is viewed from the front.



The same array viewed from the top.



Here an array is created while the object is viewed from a three-quarters angle.



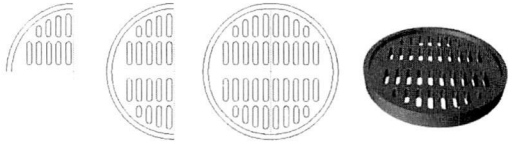
The same array viewed from the top.

Tip: Because Create Array can create many objects that fill your workspace, you might find it useful to either parent the original object(s) to a construction point or creating an array layer for the object(s) before creating the array. This provides you with greater flexibility for moving, hiding, and selecting objects in the array once it is created.

Note: Duplicate with Link and Duplicate Special duplicates any animation tracks associated with an object. Using either on an object that already has animation can produce unpredictable results.

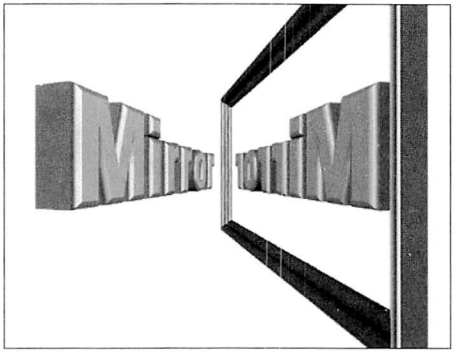
Mirroring geometry

Extreme 3D provides two tools for creating mirror images of objects. With the mirror tools you can mirror an object across a two-dimensional axis or a three-dimensional plane.



This figure shows how you can use the 2D mirror tool to mirror profiles and surfaces across an axis. The image on the far right shows the extruded and rotated object created from the mirrored profile.

Using the 3D mirror tool you can mirror profiles and surfaces across a three-dimensional plane.

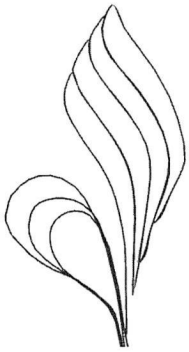


Double-click either mirror tool to open the Mirror Preferences dialog box. The current settings apply to both mirror tools. For more information on mirror tool preferences, see the Reference section of the Extreme 3D Help system.

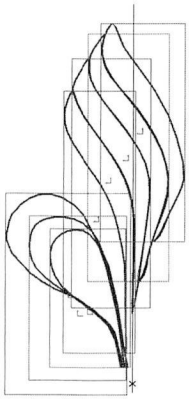
To mirror an object across a 2D axis:

1 **Select the 2D mirror tool, then select the object(s) to mirror.**

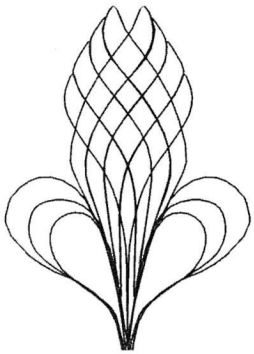
2 **Specify the direction of the axis by clicking two points in the workspace, or click and drag the direction of the axis.**
Extreme 3D draws the object across the axis as a mirror image of the original object.



The original object is a set of swept loops.



The loops are selected, and the 2D mirror tool used to define an axis.

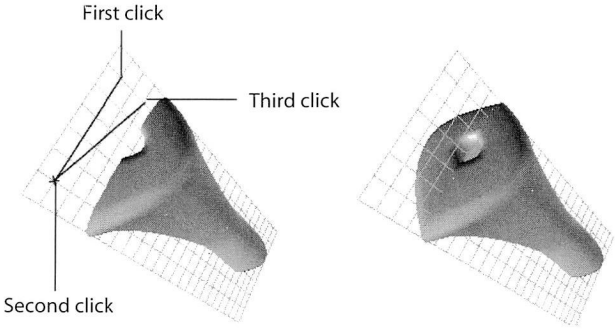


The loops are mirrored across the axis, creating this intricate design.

To mirror an object across a 3D plane:

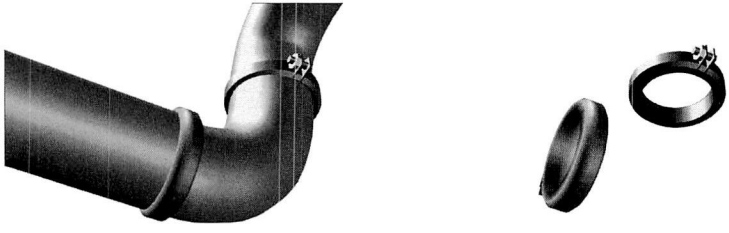
1 **Select the 3D mirror tool, then select the object(s) to mirror.**

2 **Click three points that define the plane to mirror across.**
Extreme 3D draws the object as a mirror image across the specified plane.



Hiding objects

When you're working with a complex model, objects sometimes become obscured by other objects. To unclutter the workspace and speed redraws, you can hide some objects.



In the illustration on the right, the pipe has been hidden so that only the clamps are visible.

Hiding and showing objects

To hide objects:

- Select the object(s) you want to hide. Choose Hide from the Object menu, then choose Selected Objects. Extreme 3D redraws the workspace, hiding the selected objects and any children of the selected objects from view.

To display all hidden objects:

- Choose Show All from the Object menu. If the Show All command is dimmed, all nonconstruction objects are visible.

To display a specific hidden object:

1. **Open the World browser by choosing World from the Window menu.**
2. **Double-click through the World browser hierarchy to find and select the name of the object you want to show.**
3. **Choose Show from the Object menu, then choose Selected Objects.**

Working with layers

You can organize sets of objects by assigning objects to layers. Use layers to quickly select, hide, or show multiple objects simultaneously.

To create a layer:

1 **Choose Layers from the Window menu.**
Extreme 3D opens the Layers browser. By default, all objects in the workspace are in Layer 1.

2 **Click the New button.**
Extreme 3D creates a new layer and names it Layer 2.

You can make the new layer current either by selecting the layer name in the list and clicking Current, or double-clicking the layer name. The current layer is marked by an asterisk (*) next to its name. New objects are automatically assigned to the current layer.

To assign objects to a different layer:

1 **Make the layer you want to assign the objects to the current layer.**

2 **In the workspace, select the object(s) you want to move to the current layer, then choose Move.**
Extreme 3D moves the objects to the current layer.

Once the objects you want are in the layer you want, you can choose Select to select them all, Hide to hide them all, or Show to show them all.

Note: Objects on a hidden layer can be made visible on an individual basis by clicking the visible check box on that object's page in the Objects browser, or by selecting the object by name in the World browser and choosing Show from the Object menu. The object maintains its association with the layer.

Naming layers something meaningful can help you remember what objects are contained in that layer.

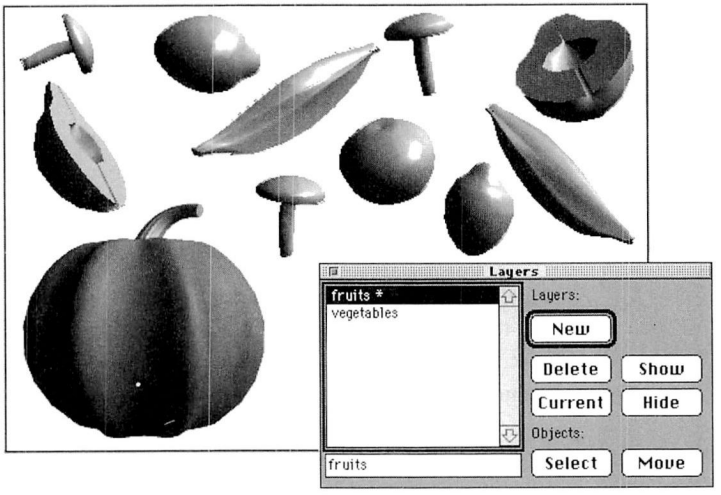
To name a layer:

1 **In the Layers browser, select the layer in the list.**

2 **Type a new name in the text entry field at the bottom of the Layers browser and press Enter.**

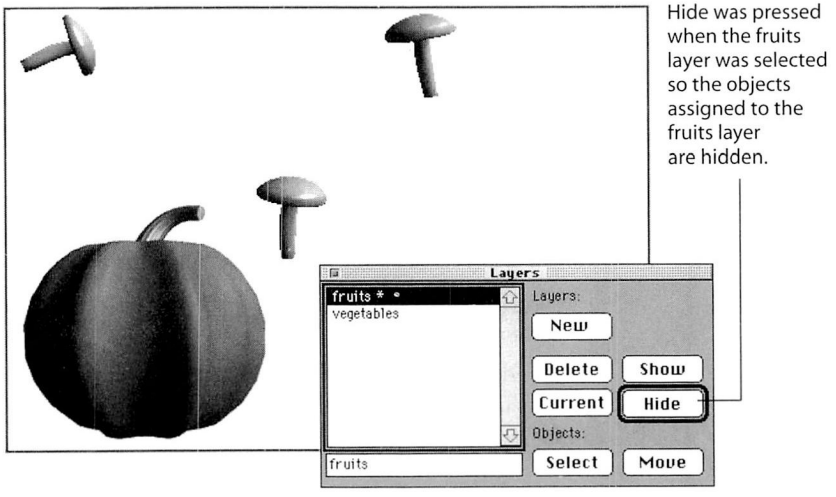
You can delete a layer by selecting it in the Layers browser and choosing Delete. Any object assigned to a deleted layer becomes assigned to the current layer. You cannot delete the current layer.

The following figure shows objects that have been assigned to different layers in the Layers browser.

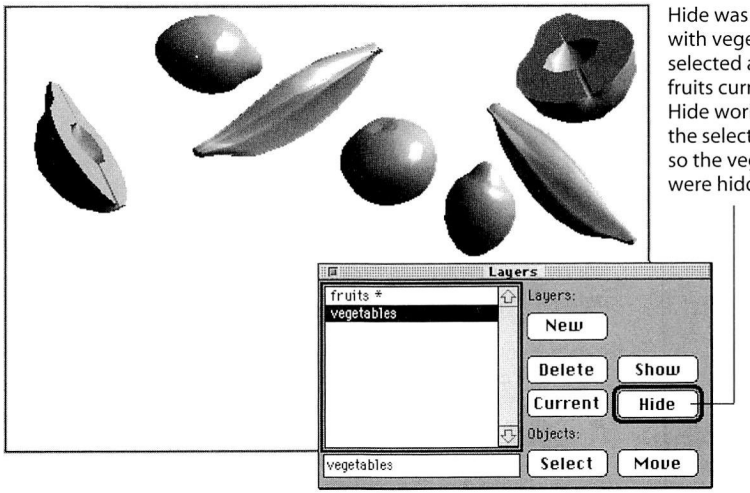


The bananas, oranges, avocados, and lemons are assigned to the Fruits layer, and the pumpkin and mushrooms are assigned to the vegetables layer. Both layers are being shown. The Fruits layer is current.

You can click Hide to make all the objects in the selected layer disappear from the workspace.



The Hide, Show, Current, Select, and Delete buttons work on the selected layer—the one that is highlighted in the list. Only the Move button works on the current layer—the one with the asterisk (*) next to it.



Hide was pressed with vegetables selected and fruits current. Hide works on the selected layer, so the vegetables were hidden.

Using construction objects

Construction objects provide reference geometry that you can use to snap or align the components of your model. You can use construction objects to create a "scaffolding" on which to place model objects. You can also link to construction objects.

In the workspace, all construction objects appear in blue to differentiate them from other types of geometry objects. You can add as many construction objects as you need.

Using construction points

Points are the simplest type of construction objects. They provide reference points in space that you can snap objects to. If you are creating complex profiles, use the Objects browser to align the points in the desired coordinates of the world, then snap to the points to draw your profile.

Construction points are placed in the workspace and a spline curve is drawn using the construction points for reference. The spline curve can later be changed into a three-dimensional object.

To add a construction point:

- Select the construction point tool and click in the workspace to add the point. The point appears as a crosshair in the workspace.

To snap the point to geometry in the world, hold down the 3 key while clicking the mouse. For more information, see "Snapping" on page 142.

Using construction lines

Use construction lines for visual reference or as geometry for aligning other geometry. Construction lines can be added to any plane in the world. By default, Extreme 3D draws construction lines parallel to the x-axis of the working plane.

To add a construction line:

- Select the construction line tool and drag a line in the workspace.

To draw the line parallel to an axis other than the x-axis of the working plane, press V (for a vertical line parallel to the y-axis), H (for a horizontal line parallel to the x-axis), or N (for a line parallel to the z-axis) while dragging a line in the workspace. You can also click and drag to position the line at an arbitrary angle on the working plane. Additionally, the following keys affect construction objects:

Key	Constraint
p	Constrains the movement of construction objects to be perpendicular to geometry in the hit radius.
t	Constrains the movement of construction objects to be tangent to geometry in the hit radius.
o*	Snaps to the plane on which the selected object was created.

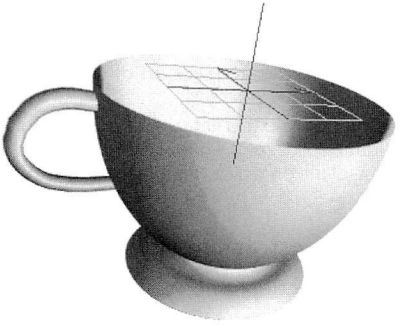
* This is the letter o, not a zero.

Using a construction axis

The construction axis tool creates an x-, y-, z-axis of construction lines. You can use it to snap geometry in the workspace, or to indicate the orientation of the world.

To add a construction axis:

- Select the construction axis tool and click in the workspace to specify the intersection of the three axes. If no objects are clicked, the construction axis assumes the orientation of the world. If an object is clicked, the axis assumes the orientation of that object.



A construction axis defines the center of this cup. When building a model, you can use the construction axis to snap other objects to the center of the cup.

Using construction grids

Similar in appearance to the working plane, a construction grid is a plane of intersecting vertical and horizontal lines for visual reference and geometry snapping.

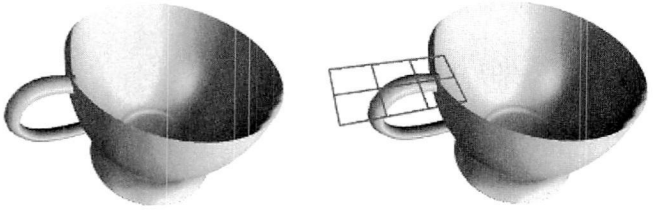
If you add a construction grid to the workspace without snapping it to other geometry, the grid automatically assumes the orientation of the current working plane.

As with rectangles and ellipses, you can use the center-corner toggle to specify whether construction grids are drawn from the center or from a corner.

To add a construction grid:

1 **Select the construction grid tool and click in the workspace to set the grid's center point or corner point.**
To snap the grid to geometry in the workspace, hold down the 3 key while clicking the mouse.

2 **To set the height and width of the grid, click another point, or drag out the dimensions of the grid in the workspace.**



The density of the construction grid depends on the number of divisions and current model scale specified in the Units dialog box. For information on specifying scale, see the Reference section of the Extreme 3D Help system.

Tip: To quickly add a construction grid to a flat surface oriented toward your view of the workspace, press the O key (the letter O, not zero) while clicking the plane or object surface. This snaps the construction grid to the plane on which that object is constructed.

Hiding and clearing construction objects

As you work with construction objects, they may obscure other objects or clutter up your workspace. Hide construction objects to view your model without removing your guides.

To hide all construction objects:

- Choose Hide from the Object menu, then choose Construction Objects.

To display hidden construction objects:

- Choose Show from the Object menu, then choose Construction Objects.

At any time, you can remove all construction objects from the world in a single operation.

To remove all construction objects:

- Choose Clear Construction Objects from the Object menu. Extreme 3D removes all construction objects (including hidden construction objects) from the workspace.

Tip: Use the Clear or Cut command to remove selected construction objects.

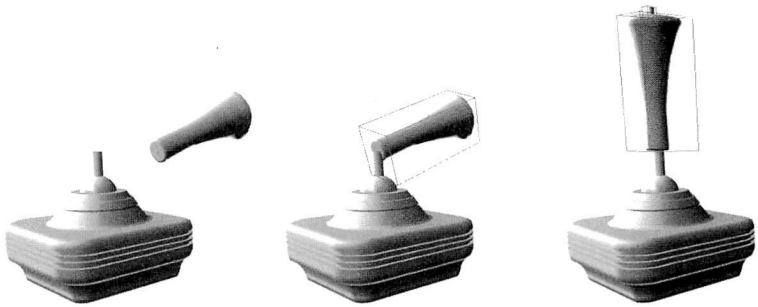
Aligning objects to one another

Alignment is a powerful technique for assembling objects into a model. You can align the position and orientation of selected objects with their parent object. If an object is not linked to another object, you can align it to the orientation of the world.

Alignment is especially useful for building models of objects with many children and grandchildren. You can work on objects separately and then use the appropriate command to align the objects.

The Align commands on the Object menu provides three options for aligning objects. You can:

- Align the position of the object's center point with that of its parent.
- Align the orientation of the object with that of its parent.
- Align both the orientation and the position of the object's center point with that of its parent.



In the illustration on the right, the joystick handle has been created in the workspace. In the center illustration, its position is being aligned with that of the base. In the illustration on the left, its orientation is being aligned with that of the base.

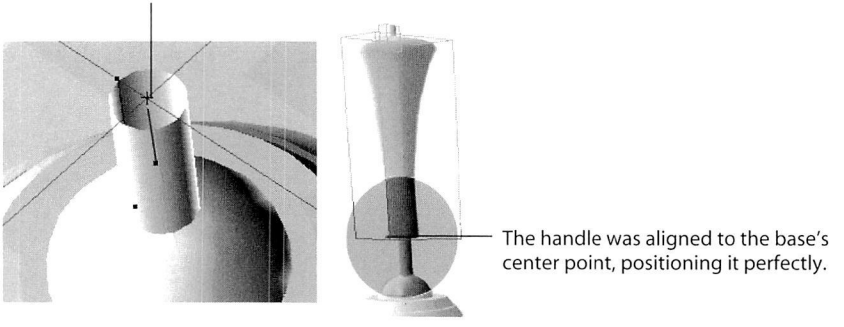
To align the position or orientation of an object:

- Select the object that you want to align, then choose the appropriate option from the Align commands on the Object menu. Extreme 3D aligns the object to its parent. If the object has no parent, Extreme 3D aligns the object with the center of the world.

Tip: To align objects without parents to each other, select the objects and choose one of the Align commands. Each selected object aligns to the world (and effectively to each other). You can also use this technique to align objects with the same parent to each other.

When aligning objects, Extreme 3D uses the center points of the objects (and the world) as reference points. You can view an object's center point by opening the object for editing. The object centers of both the joystick shaft and the handle have been moved to the surface of the object. When the objects are aligned, their center points will meet. For more information about moving a center point, see "Repositioning an object center" on page 203.

For more sophisticated linking and alignment, use the center point tool to reposition object center points before aligning the objects. For example, by moving an object center to the surface of an object, you can align its child object to the surface instead of to the interior.



Chapter Four
Animating

This chapter introduces you to the techniques and tools you use to animate objects and properties in E3D. It contains these topics:

- **Identifying the animation components**—familiarizes you with the parts of the user interface you use to create animation in Extreme 3D.
- **Setting animation preferences**—describes some preferences you might want to change before you begin animating.
- **Animating in the workspace**—explains how to use Extreme 3D's tools and Objects browser to animate objects interactively in the workspace.
- **Animating in the score**—touches upon each of the animation techniques that are handled by Extreme 3D's score.
- **Animating the camera**—discusses how to animate the camera and its view.

Animation in E3D

Animation is the illusion of movement created by rapidly displaying a series of images in various stages of change. Each individual image in an animation is referred to as a *frame*.

In computer animation, the animator creates the critical times in the animation, such as at the beginning and ending of an object's movement or at the moment where a color or other property change occurs. These times are called ***keyframes***. Then the computer generates the transitional changes between these keyframes.

While most people think of animation as motion, that is only one of many dimensions you can animate in Extreme 3D. For example, in addition to animating an object's position, orientation, and scale, you can change the color or transparency of an object's material over time. Or you can add multiple lights to an Extreme 3D scene and animate them as objects. You can also animate such properties as the intensity or cone angle of a light, or the view distance or look-at point of the camera.

Any attribute of an object, a light, a material, or the camera that can be animated is referred to as a ***property***. Each property appears as a ***track*** in the Extreme 3D score. Each track contains all the animation values of one property. These values are stored as spline curves and not as a sequential list of values. They behave like spline curves in that they have control points—represented by keyframes—and tangent lines at those keyframes.

You can approach animating in Extreme 3D in a number of ways. The same tools you use for modeling objects and positioning, rotating, and scaling them in the workspace can also be used to animate them interactively in the workspace. You can animate the properties of objects by changing their keyframe values in the browsers or the Extreme 3D animation score. Animation can also be done by creating tracks and keyframes directly in the score. Extreme 3D's camera is also completely animatable. Other powerful animation features, such as animating the properties of lights and materials, are covered in the next chapter.

Identifying the animation components

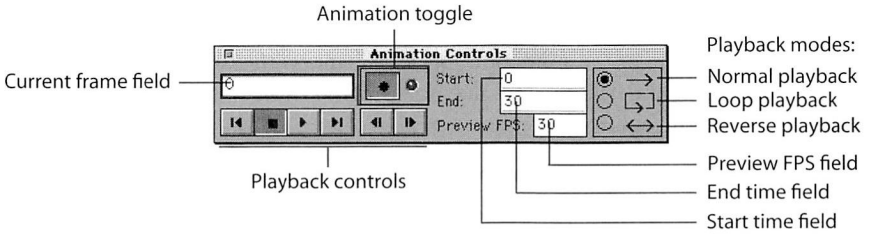
When you create animation in Extreme 3D, you use the ***animation controls*** and the score.

The animation controls

The animation controls regulate the current time and the length and playback mode of animation sequences.

To open the animation controls:

- Choose Animation Controls from the Animate menu.



The time fields

The animation controls have several fields that control time.

The ***current frame field*** at the top of the panel shows the current animation time. You can change the value in the current frame field to create new keyframes or to advance the animation to an existing keyframe or to another time. The ***start time*** and ***end time*** determine the beginning and ending points of the animation playback. The time value in these fields is displayed in either frames (0) or seconds (0.00), depending on which option you select in the Preferences dialog box.

The ***preview FPS*** sets a temporary frames-per-second rate for previewing animation sequences in the workspace. Smaller numbers result in fewer frames being drawn for each second of animation. This creates a faster preview. The preview FPS temporarily overrides the final output FPS that you set in the Preferences dialog box.

To change the values in any of these fields:

- Click and drag to highlight the field. Then type in a new value and press Enter. Once you have typed a value into any one of these fields, you can tab to the other fields to change their values.

The playback modes

The ***playback modes*** determine how the animation will playback.

The normal setting plays the animation sequentially from the start time to the end time; loop plays the animation repeatedly from the start time to the end time until you choose to stop; reverse playback plays the animation forward (from the start time to the end time), then plays it in reverse (from the end time to the start time) continuously.

The ***playback controls*** work like standard VCR controls: play, stop, rewind, fast forward, step backward, step forward.

The animation toggle

The animation toggle should be on, that is depressed with its record light red, when you want the changes you are making to be animated. This is the default state of the animation toggle. Whenever the toggle is on and the current frame field to any value other than 0 (frames) or 0.00 (seconds) you are creating animation.

To make temporary changes to the scene, such as moving an object in order to check another object behind it, toggle the button off. Any change you make to a property that is already animated reverts to its previous state when the button is toggled back on. Changes made with the animation toggle off to properties that were not previously animated retain those changes when the button is toggled back on.

To make a change to an object's beginning position, shape, or other initial property, or to make a lasting change to an object that does not animate, leave the animation toggle on and make the change at ***time zero,*** the point at which all animation begins in Extreme 3D, by setting the current frame field to 0 (frames) or 0.00 (seconds).

For more about the animation controls, see the Reference section of the Extreme 3D Help system.

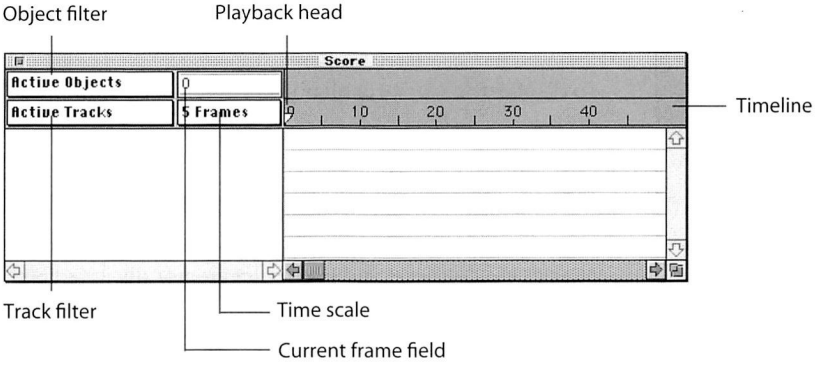
The score

The ***score*** contains all the time information about each object and property in your animated scene. It can be thought of as the animation browser.

To open the score:

- Choose Score from the Animate menu.

Several components of the score help you manage animation data. They are the timeline and time scale, the playback head and current frame field, and the objects and track filters.



The timeline, time scale, current frame field, and playback head

The *timeline* along the top of the score displays the time continuum of your animation as calculated by the frames-per-second value you set in the Preferences dialog box. These values are displayed in either frames (0) or seconds (0.00), also set in the Preferences dialog box, and in increments determined by the current *time scale.*

To change the time scale:

- Click the time scale pop-up and choose a frame count. A smaller frame count displays a smaller portion of the tracks and expands the distance between keyframes. A larger frame count displays a larger portion of the tracks and shrinks the distance between keyframes. The time values in the timeline also change to reflect the time scale.

You can use the ***playback head*** to set the current time. When you drag the playback head towards either edge of the timeline you change the current time and the current frame field updates accordingly. The current frame field in the score and the current frame field in the animation controls always display the same value.

Dragging the playback head scrolls the score and plays the animation in the workspace. You can study a particular section of animation by dragging the playback head back and forth.

Note: By pressing the Alt key (Windows) or the Option key (Macintosh) while dragging the playback head along the timeline, you can see the values of the currently selected track update dynamically in the dynamic display area above the timeline.

The objects filter

The *objects filter* allows you to choose the type of objects for which you want animation information displayed. Selective display of object names can increase Extreme 3D's efficiency. Occasionally you may want to see the names of all the animated objects in the scene.

To display the names of all objects that can be animated:

- Click the objects filter and choose All Objects.

You can use the triangles to the left of object names to organize what appears in the score. A downward triangle indicates that the names and properties of all an object's child objects are displayed. A right-pointing triangle indicates that an object's child objects and properties are not displayed.

To display or hide an object's child objects and properties:

- Click the triangle next to the object's name.

The track filter

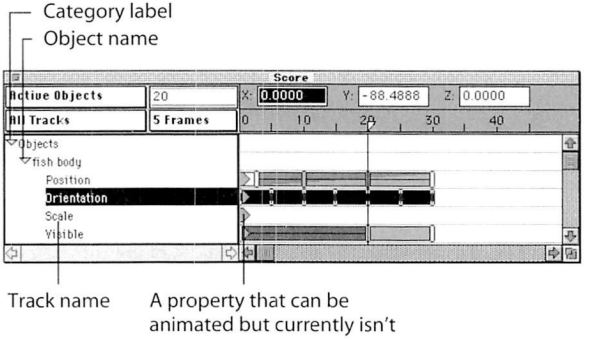
The *track filter* allows you to choose the properties for which you want animation information displayed. As with the object filter, selective display of tracks increases efficiency.

To display all tracks for all properties:

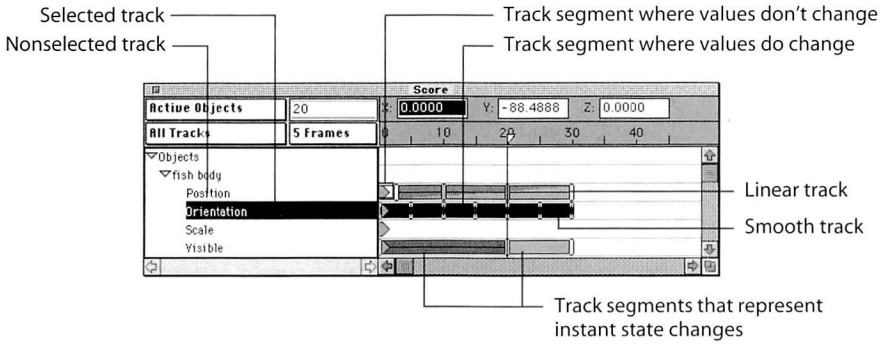
- Click the track filter and choose All Tracks.

The tracks

Two other score components—tracks and the keyframes—store animation data for the current scene. A track represents and stores all the animation information that belongs to a single property throughout the length of the animation. Tracks are labelled and color-coded to present several kinds of additional information at a glance.



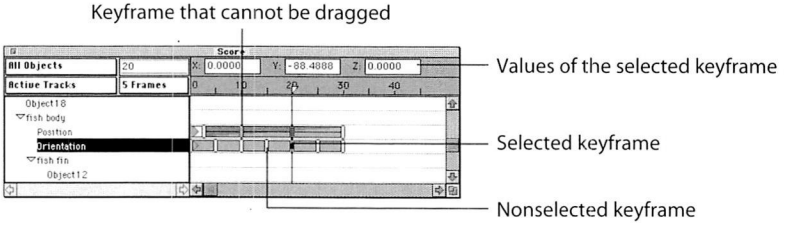
- Before you begin animating, all properties that can have tracks are represented in the track area of the score by a gray triangle at time zero.
- When a track's name is selected in the list, the name, the track, and all its keyframes are highlighted.
- Track segments in which the beginning and ending keyframes have different values are colored light gray. Tracks for position, orientation, and color properties are examples of tracks that normally have a new value at each keyframe.
- Tracks that represent instant state changes, such as visibility, are colored dark gray when the track represents the on state and light gray when the track represents the off state.
- Inactive tracks and track segments that contain no change in value between keyframes are colored white.
- Track segments to which ease in or ease out have been applied are indicated by a dark to light gray ramp that corresponds to the duration of the ease.
- By default, changes between keyframes are interpolated by Extreme 3D using a ***smooth motion style***. The Change Motion Style command lets you specify a ***linear motion style*** for changes between keyframes. Track segments that you have changed to linear motion style, and tracks that are linear by default, such as visibility, are represented with a median line.



The keyframes

The keyframes represent the specific animation information that a property has at a specific time. Keyframes are also color-coded.

- Keyframes are white, except when they are selected. Then they are red.
- When a keyframe cannot be dragged with the mouse, for example, when it occurs in the middle of a track segment with easing applied, it is colored gray when unselected and blue when selected.



The keyframe values for the keyframe at the current time in the currently selected track appear in the *dynamic display area* at the top of the score. Depending on what property a keyframe represents, this area displays numeric displays, check fields, or sliders.

In Extreme 3D you create keyframes by setting the current time at which you want a change to be completed and then make the change you want. The value of the first keyframe is the value of the property before the change is made.

To change the value of the currently selected keyframe at the current time:

1. **Select a track.**
2. **Depending on the property whose value you are changing, type in a value, select a color or drag the slider bar.**
3. **Press Enter.**
   The value of the keyframe is changed for that time. If there is no keyframe at the current time, a keyframe with the designated value is created.

Setting animation preferences

The animation page of the Preferences dialog box contains several preferences that affect animation. You might want to set two of the preferences before you begin animating: the time mode preference and the frames-per-second preference. Other preferences are discussed later in this chapter and in the Reference section of the Extreme 3D Help system.

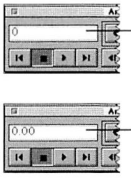
To open the Preferences dialog box:

- Choose Preferences from the Edit menu and click the Animation page.

The *time mode* preference determines how time is displayed in the current frame field of the animation controls and the score. It also determines how time is represented in the timeline of the score. You can choose either frames or seconds. Frames is the default. Because keyframes snap to whole frames when they are inserted or dragged, working in frames is the best way to ensure that the times you indicate as keyframes are actually rendered as frames. Using seconds is especially useful if you know you want to output your animation at several different frame rates for it to play in a variety of media. The two time modes are interchangeable. That is, you can change from frame mode to second mode or vice versa and not lose any timing or keyframe information.

To set the time mode:

- Choose frames or seconds under the Display Time In mode preference.



Display of time mode preference set to frames

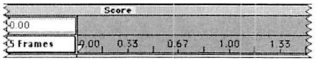
Display of time mode preference set to seconds

The *frames per second* preference controls the number of frames that will be generated for each second of animation.

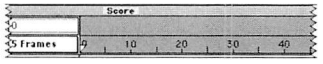
Thirty frames per second is standard for NTSC video output. Other common values are 25 frames per second for PAL video output and 15 frames per second for CD-ROM digital video. The fewer frames per second, the faster the motion appears. Frames per second also determines the values used in the timeline of the score.

To set frames per second:

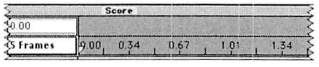
- Type a value into the Frames Per Second preference.



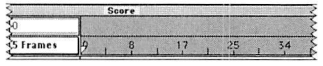
Time mode set to seconds and frames-per-second set to 30.



Time mode set to frames and frames-per-second set to 30.



Time mode set to seconds and frames-per-second set to 25.



Time mode set to frames and frames-per-second set to 25.

Note: For faster previews, the frames per second setting can be temporarily changed in the animation controls. This doesn't change the final output frames per second values, which is determined by the frames per second preference.

To accept all changes to the animation preferences:

- Click OK.

Animating in the workspace

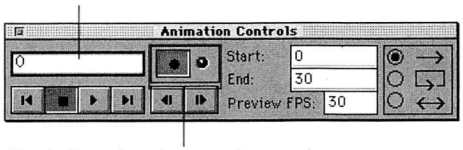
Although Extreme 3D provides an animation score, many kinds of animation can be created directly in the workspace. For example, you animate the positions, orientations, and scales of objects directly in the workspace. You can link objects and animate using those links in the workspace. You can even view your animation through the camera without having to open the Extreme 3D score. This section discusses the following animation techniques:

- Animating an object's position in the workspace
- Creating and editing animation paths in the workspace
- Animating an object's orientation in the workspace
- Animating an object's scale in the workspace
- Animating with links in the workspace
- Using construction objects as animation aids

Before you begin animating in the workspace:

- Choose Animation Controls from the animate menu to open the animation controls.

Check the current frame field to make sure it is at zero.



Check the animation toggle to make sure the red record light is on.

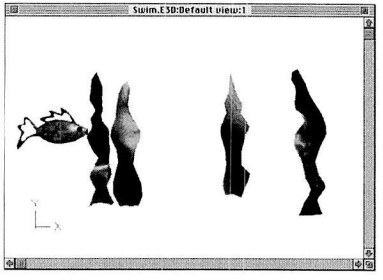
You might want to use the sample files Extreme 3D provides to help you step through the tasks in this section. The files in this chapter are included with Extreme 3D. By default, they are installed in the Examples folder or directory.

Animating an object's position in the workspace

Any object movement technique or tool you can use for modeling can be used to animate the position of any object in the workspace. These include moving objects with the arrow tool, nudging objects with the arrow keys, and entering new position values for objects in the Objects browser.

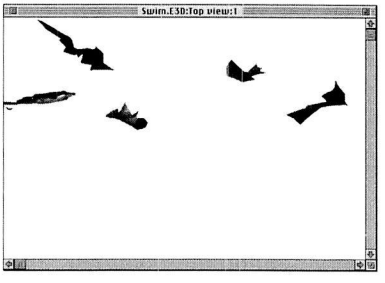
To use the Extreme 3D sample file for this task:

1 **Choose Open from the File menu and open the file Swim.E3D.**



The fish is positioned to swim through the seaweed.

2 **Choose Top from the Views menu.**

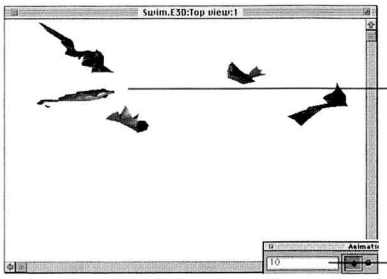


To begin animating:

1 **Select an object you want to animate, for example, the fish.**

2 **In the current frame field of the animation controls, type the time at which you want the movement to be completed and press Enter.**

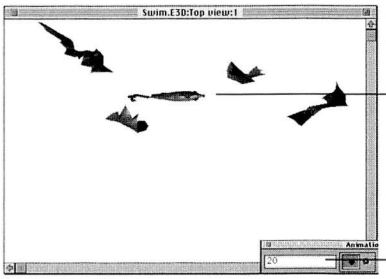
3 **Move the object in the workspace.**



The fish has been moved into the seaweed.

The current time value is set to 10.

4 **To continue animating the object, increase the current time value in the animation controls to the next time at which you want a movement to be completed and move the object again.**



The fish has been moved further into the seaweed.

The current time value is set to 20.

Saving your animation and playing it back

Once you have created some animation you might want to save it. It is also useful and rewarding to periodically play your animation back.

To save your animation data:

- Choose Save from the File menu. You are prompted to name the file if it is new. Because all animation information belongs to the object with which it is associated, Extreme 3D saves it in the scene file.

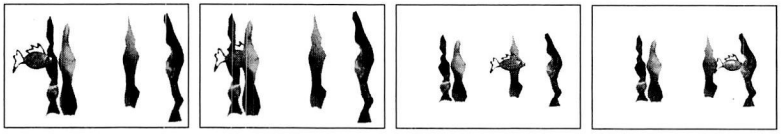
To play your animation:

1 **Choose a view from which you want to view the animation.**

2 **Choose Animation Controls from the Animate menu to open the animation controls.**

3 **Type the start and end times you want for the playback in the Start and End text entry fields of the animation controls.**
To playback your whole animation, type 0 into the Start field and the value of your last frame in the End field.

4 **Click rewind in the animation controls and then click play.**
As the animation plays, the values for all times between the keyframes you set are interpolated by Extreme 3D.



Frame 2 *Frame 12* *Frame 22* *Frame 30*

There are several options for speeding up your playback if it seems slow. One way is to view the animation in bounding box render style.

To play your animation using bounding box render style:

1 **Choose Preferences from the Edit menu and click the Animation page.**

2 **Choose Bounding Box Render style.**

Another way to speed up playback is to change the preview FPS setting. Using this method, Extreme 3D creates fewer frames so the entire animation displays more quickly.

To change the preview FPS setting:

- Type a value into the Preview FPS text entry field and press Enter. A smaller number draws fewer frames per second and speeds up playback. A larger number draws more frames per second and slows down playback.

Note: Changing the preview FPS does not scale the animation. For more information, see "Fine-tuning animation motion and timing" on page 296.

You can see the animation of some lighting and materials effects in shader mode while playing back an animation in the workspace. You can test the effect of lights or materials that are not viewable in the workspace by rendering single frames to your screen using final render settings.

To render a single frame of your animation to the screen using final render settings:

- Choose Final Render to Screen from the Render menu.

For more information, see "Optimizing animation playback" on page 323.
For more information about rendering and rendering set up, see Chapter Six, "Rendering."

Editing animation paths in the workspace

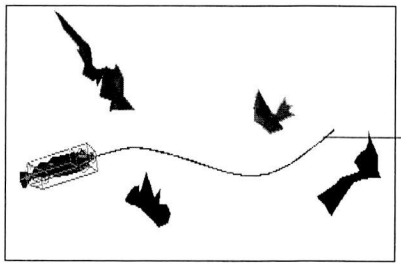
Once an object's position has been animated, its animation path can be displayed and edited in the workspace. Animation paths look like spline profiles in the workspace, except that they are blue. In most ways they behave and can be treated just like any other spline curve.

To use the Extreme 3D sample file for this task:

- Choose Open from the File menu and open the file Swim1.E3D.

To display an object's animation path:

1. **Select an object whose position has been animated, such as the fish.**
2. **Choose Animation Path from the Animate menu and then choose Show.**



The animation path of the fish through the seaweed.

As with any spline curve, you can open the animation path's geometry to display the control points that comprise the path.

To open the animation path:

1. **Select the animation path.**
2. **Choose Open Geometry from the Object menu.**
   The animation path and all of its control points are displayed. Optionally, you can simply double-click the path in the workspace.

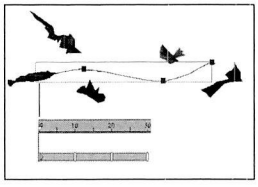
Each control point along the animation path in the workspace relates to one of the keyframes of the position track in the score.

To see the relationship of control points and keyframes:

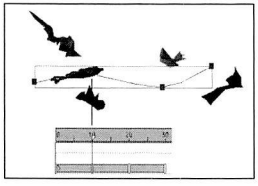
1 **Open the score by choosing Score from the Animate menu and position its window so the workspace is unobstructed.**

2 **Set the current frame field to 0.**

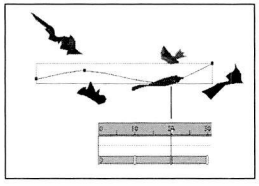
3 **With the animation path open in the workspace, drag the playback head along the timeline and watch both the position track of the object in the score and the object in the workspace as it moves along its path.**
Each control point on the animation path corresponds to a keyframe in the animation. Notice that the object passes over a control point on the animation path in the workspace at the same time the playback head passes over a keyframe in the score.



Frame 0



Frame 10



Frame 20

Note: The keyframe-to-control-point relationship does not apply if easing is applied to a track or track segment. For more information see "Modifying the motion style of a change" on page 296.

Creating an animation path from a profile

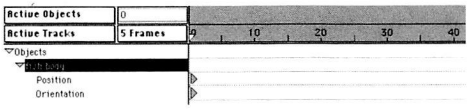
Another quick way to create an animation path for an object is to create a profile first and then convert it into an animation path. You can create a profile for use as an animation path using any of the tools or commands that generate splines or polylines. Any profile can be converted to an animation path including profiles that have control points in all three dimensions. You can even use circles, ellipses, and any text outline as animation paths. For more information about creating profiles, see Chapter Four, "Animating."

To use the Extreme 3D sample file for this task:

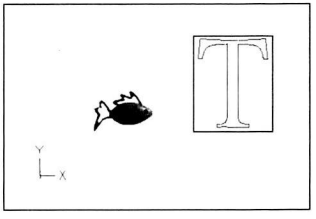
- Choose Open from the File menu and open the file Tfish.E3D.

To use the T profile as an animation path:

1 **Open the score and select the name of the object whose position you want to animate.**

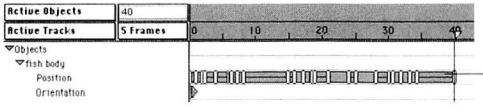


2 **In the workspace, select the spline profile you want to use as that object's animation path.**
If the spline also appears as an object in the score, selecting it in the workspace will reset the score's selection. Use the track and object filters to make sure that the spline object doesn't appear in the score before you perform this step.



3 **Set the current frame field to the time at which you want this animation to end.**

4 **Choose Animation Path from the Animate menu and choose Convert Profile to Path.**
The profile becomes the object's animation path. It disappears until you choose animation path from the animate menu, then choose show. If the selected object does not have a position track, create one first by nudging the object slightly with the arrow key. If the selected object already has a position track, the beginning and ending times are retained and the position values of the control points of the profile are used as the new position values for the intermediate keyframes.



The fish now has a position track in the score.

Note: If you convert a profile to a path at time zero for an object that already has a position path, the end time of that position path becomes the end time of the new converted path.

Creating a profile from an animation path

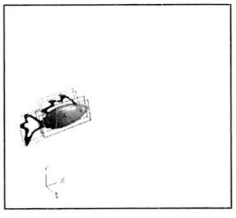
Just as any profile can become an animation, any animation path can be converted into a spline and used as a profile for creating a surface object. This can be useful for creating objects, such as tunnels, through which another object animates. Converting an object's animation path into a profile does not destroy the animation path. The object still moves along its animation path and the path itself can still be shown or hidden.

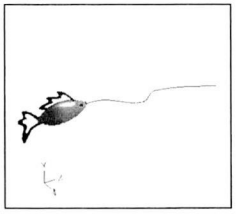
To use the Extreme 3D sample file for this task:

- Choose Open from the File menu and open the file Fishcave.E3D.

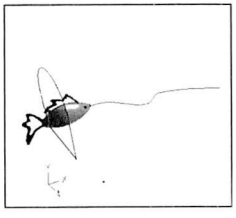
To convert an animation path into a profile:

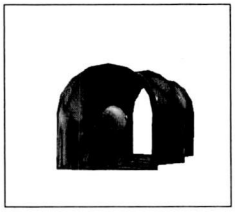
1. **Select an object whose position has been animated, such as the fish.**
2. **Choose Animation Path from the Animate menu and choose Convert Path to Profile.**
   A profile that is a copy of the animation path is created and the animation path of the object is retained.





The resulting profile can be used with any of the Extreme 3D modeling tools to create a new surface object.





An arch profile swept along the converted animation path creates a cave for the fish to swim through.

Changing an object's timing by manipulating control points

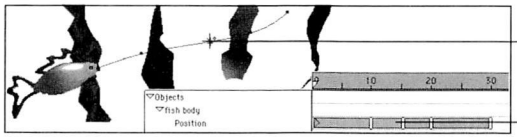
As with any other spline curve, you can add control points to and delete them from the animation path. Adding control points to the animation path adds a keyframe to the object's corresponding position track in the score. Deleting a control point deletes the corresponding keyframe. Extreme 3D interpolates the keyframe time of a new control point from the keyframe times of the adjacent control points.

To use the Extreme 3D sample file for this task:

- Choose Open from the File menu and open the file Swimani.E3D.

To add animation path control points:

- Select the control point tool from the tool palette, then click between two control points anywhere along the animation path.

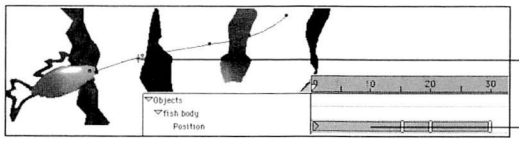


A control point is added to the path.

A new keyframe appears in the score.

To delete animation path control points:

- Press the F3 key (Windows) or Option key (Macintosh) and click the control point you want to delete.



A control point is deleted from the path.

Its keyframe is deleted from the score.

Note: Adding or deleting animation path control points does not change the motion or timing of the object's animation. You can change the timing of a control point by dragging its corresponding keyframe to a new time in the score. For more information, see "Assigning new values to keyframes" on page 273. You can change the way it moves by editing its tangent lines. For more information, see "Changing an object's motion style by manipulating control points" on page 244.

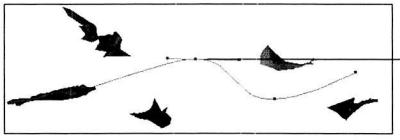
You can change the relative positions of control points along the animation path in the workspace and change how quickly the object moves between keyframes. Moving a control point does not change the time at which its corresponding keyframe occurs, so an object moves faster between two control points if you move them farther apart and slower if you move them closer together.

To change a control point's position along the path:

1 **Select the animation path.**

2 **Double-click the animation path to open its geometry.**

3 **Select a control point on the animation path and drag it to a new position.**

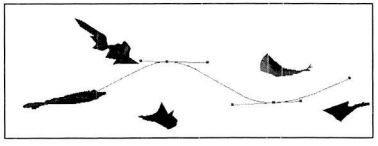


A control point is moved to put a greater curve in the animation path.

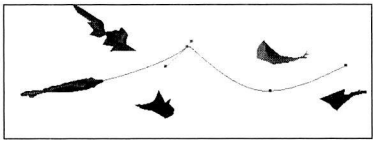
Note: When you change the position of a control point along an animation path, the path's curve changes shape. You can maintain the quality of an object's movement after you adjust a control point's position by adjusting the tangent lines of the control point to approximate the path's previous shape.

Changing an object's motion style by manipulating control points

The shape of the animation path plays a part in how the object moves. For example, a more gradual curve produces a smoother movement. Extreme 3D creates this smooth motion style by default. You can change the shape of an animation path by adjusting the tangent lines of its control points.



This animation path has gradual curves that produce smooth motion.



This animation path has a sharp curve that produces an abrupt motion.

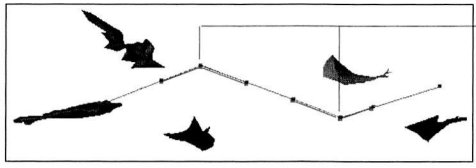
The tangent lines of a control point are always tangent to the spline curve but do not need to lie in the same straight line as each other. When the tangent lines of two adjoining control points lie along the animation path and point directly at each other the object changes direction sharply at each control point. This is called linear motion style. The only way to produce absolutely linear movement in a range of keyframes is to use Change Motion Style. For more information, see "Fine-tuning animation motion and timing" on page 296.

However, you can create sharper changes of direction in an object's movement at its control points by breaking the tangent lines relationship to one another.

To create an animation path that produces sharp movement:

1 **Select a control point along the animation path where you want the motion to make a sharp change in direction.**

2 **Press the B key while dragging a tangent line end point.**



This animation path produces sharp changes in direction at those control points.

Animating an object's orientation in the workspace

Any object rotation technique or tool you use for modeling can be used to animate the orientation of any object in the workspace. This includes using constraint keys with the arrow tool or arrow keys, using the rotate point and rotate axis tools, using the track ball in the Objects browser, and entering new orientation values for objects in the Objects browser.

There are a number of ways to calculate a change in orientation in three-dimensional space. Extreme 3D stores rotation information as ***quaternions,*** a set of four values that together describe an object's position and its orientation relative to that position. Extreme 3D's calculation of rotations may not produce the interpolated values you expect. However, the values at keyframes are correct. This kind of calculation prevents a situation called ***gimbel lock*** in which the object loses the freedom to rotate around one or more of its axes.

Use this calculation to make a full 360 degree rotation that moves consistently in one direction and doesn't take a short cut to its starting point, it is necessary to create a keyframe for at least every 179 degrees of rotation. It is possible to do this manually in the workspace using any of the rotation tools and techniques listed above. However, the Auto Rotate command, described in "Creating rotations greater than 180 degrees" on page 251, automatically creates the right number of keyframes to perform rotations greater than 180 degrees and multiple rotations.

To use the Extreme 3D sample file for the next several tasks:

- Choose Open from the File menu and open the file Swim1.E3D.

Animating rotations using the arrow tool

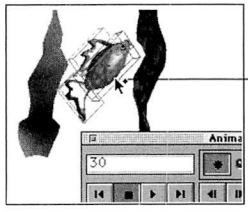
The easiest way to animate objects' orientations is with the arrow tool or arrow (nudge) keys using the rotation constraint keys.

To perform a rotation using the arrow tool:

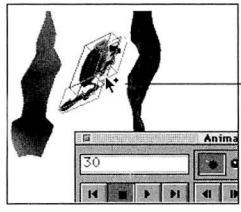
1 **Create or select an object you want to animate, for example the fish.**

2 **In the current frame field of the animation controls, set the time or frame at which you want the rotation to end and press Enter.**

3 **Drag the object in the direction of the rotation you want using the modifier keys described below to constrain the rotation to a pair of axes.**
By default, the interactive rotation of an object with the arrow tool or arrow keys occurs around a pair of axes.



Rotating the fish around the x- and y-axes.



Rotating the fish around the y- and z-axes.

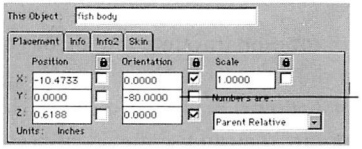
To do this	Do this in Windows	Do this on Macintosh
Rotate an object around x and y only	Press F4 while dragging the object	Press Command while dragging the object
Rotate an object around y and z only	Press F3 while dragging the object	Press Option while dragging the object

Sometimes you might want to be sure you are rotating an object around only one axis. A pinwheel, a propeller, and a crank handle all rotate around a single axis.

To constrain a rotation to a specific axis:

1 **Choose Objects from the Window menu to open the Objects browser.**

2 **Check the lock boxes beside the orientation fields of the two axes you do not want the object to rotate around.**



With this setting, the fish body rotates only around its y-axis.

3 **Follow the steps for animating a rotation with the arrow tool.**

Note: You can also use the arrow keys with rotation constraints to nudge the object's orientation. If you do, remember to set the Nudge Angle in the Preferences dialog box to get the nudge response you want.

Animating rotations using the rotate point and rotate axis tools

Another way to animate an object's rotation less than 180 degrees in the workspace is using the rotate point or rotate axis tools. Which rotate tool to use depends in part on the view you are using and whether you want to rotate the object in a single plane or in three-dimensional space.

The rotate point tool works best for rotating objects in a single plane or objects that are parallel to your view. The rotate axis tool is useful for animating rotations in three-dimensional space.

To animate an object using the rotate point or rotate axis tool:

1 **Select an object you want to animate, for example the fish in Swim1.E3D.**

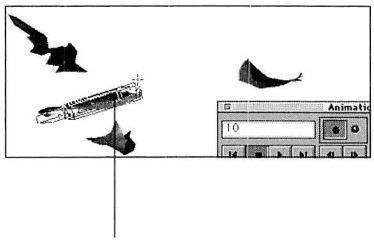
2 **In the current frame field of the animation controls, set the time or frame at which you want the rotation to end and press Enter.**

3 **Choose the rotate axis tool or rotate point tool.**

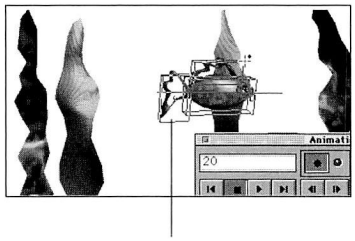
4 **Define the center of rotation (rotate point) or axis of rotation (rotate axis).** Click anywhere on the object to define the point around which you want the object to rotate (rotate point) or click to define the axis start point. Click again to define the end point. You can use the 3 key to snap end points to any location in the Extreme 3D world (rotate axis).

5 **Click a point on the object that you want to use as a handle for rotating the object.**

6 **Drag the handle around the center or axis of rotation 180 degrees or less.** Dragging more than 180 degrees can result in a rotation that appears to move in the direction opposite to your dragging direction.



Rotating the fish around a center of rotation (rotate point).



Rotating the fish around an axis of rotation (rotate axis).

7 **To create another rotation, set a new time or frame value in the current frame field of the animation controls and repeat these steps.**

Animating rotations using the Objects browser

Object orientation can also be animated using either the orientation trackball or the orientation text entry fields in the Objects browser. Rotating the object with the trackball is similar to rotating the object in the workspace. It is often useful for rotating objects that are small or hidden. If you know the exact number of degrees that you want a rotation animation to be, you can use the Objects browser to specify that value.

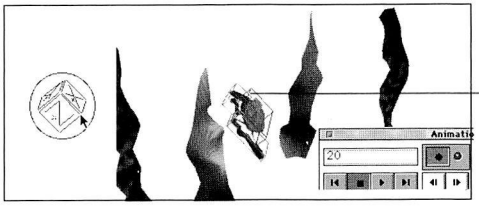
To animate an object's orientation using the Objects browser:

1 **Select an object you want to animate, for example the fish in Swim.E3D.**

2 **In the current frame field of the animation controls, set the time or frame at which you want the rotation to end and press Enter.**

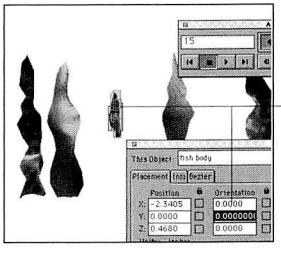
3 **Choose Objects from the Window menu to open the Objects browser, then animate the rotation using either of these methods.**

◇ Click and drag the x, y, or z face of the trackball to rotate the trackball.



In the workspace, the object and its axis reflect the changes you make using the trackball.

◇ Type the new rotation values in the x, y, or z orientation fields and press Enter.



In the workspace, the object and its axis reflect the values you enter in the orientation fields.

Moving an object's center point to create a custom rotation

Except when they are being rotated with the rotate point and rotate axis tools, objects always rotate around their center points. Most objects default to having their center point in the geometric center of the object. Some, however, have centers that are offset, like cones. Also, some animated rotations, a glass tipping over for example, require that the object rotate around a point that is not its geometric center point. To create the rotation animation, you want to move the center point of the object first.

To move the object center point before rotating it:

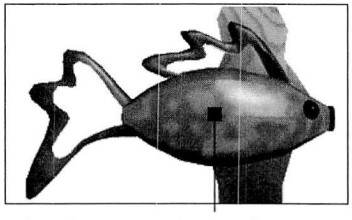
1 **Create an object you want to animate.**

2 **Double-click the object to open its geometry and expose its green center point.**

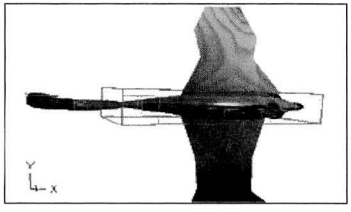
3 **Choose the move object center tool.**

4 **Click the object you are animating and drag to the point around which you want it to rotate.**
The green dot that indicates the object's center moves to wherever the cursor is when you release the mouse.

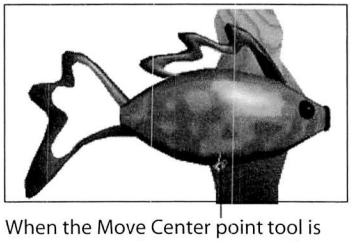
5 **Perform the rotation steps described earlier in the procedure that begins "To perform a rotation using the arrow tool:" on page 246.**



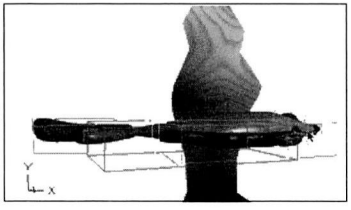
When the center point is in the center of the fish,



...the fish rotates around its center.



When the Move Center point tool is used to move the center point of the fish to its belly,



...the fish rotates around its belly.

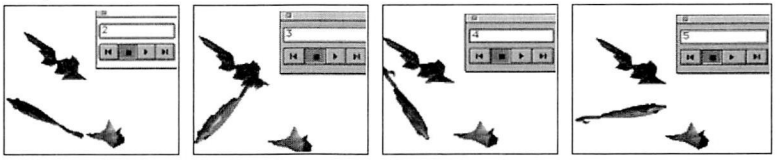
Note: An object's center point may be moved to any point in the Extreme 3D world at anytime. The center point, however, cannot be animated, and its placement affects all rotations and scales of the object as well as the placement of some materials. Therefore, it is best to move the center point at time zero and test other operations it might affect.

Creating rotations greater than 180 degrees

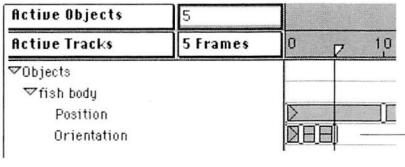
To quickly create the keyframes needed for rotation animations greater than 180 degrees, or to spin an object repeatedly, use the Auto Rotate command.

To animate an object's rotation 180 degrees or more:

1. **Select the object you want to animate.**
2. **In the current frame field of the animation controls, type the time or frame at which you want the rotation or multiple rotation to end. Press Enter.**
   Auto Rotate calculates the keyframes for the rotation so that the rotation is completed at the current keyframe and begins at the previous keyframe in the rotation track.
3. **Choose Auto Rotate from the Animate menu.**
   The Auto Rotate dialog box opens.
4. **Enter any number of degrees for the rotation in the Degrees to Rotate field.**
5. **Click the Axis of Rotation option that you want.**
   Use the object axis and the trackball in the Objects browser to help you decide which axis is appropriate for the movement you are creating, if you use any of the object axis options. The working plane option rotates the object around the z-axis of the working plane.
6. **Click OK.**
   Extreme 3D performs the rotation and calculates and displays the corresponding keyframes in the object's orientation track in the score.



The fish rotates 360 degrees over 5 frames of animation.



Auto Rotate creates three new keyframes for each 360 degree rotation.

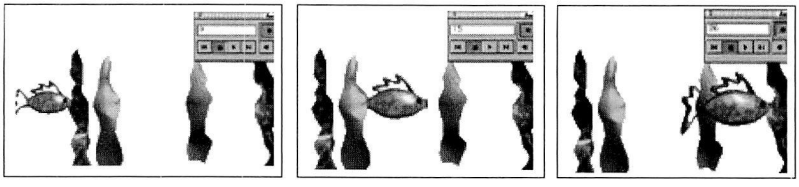
Tip: To define precisely where a rotation begins, insert a keyframe in the orientation track of the object you are animating at the time you want the rotation to begin and assign it the beginning value you want. Do this before following the steps for creating multiple rotations. For more information, see "Creating and selecting tracks and keyframes" on page 262.

Animating an object's scale

You can animate the scale of objects. When an object is scaled, it grows or shrinks around its center point. While the center point of an object cannot be animated—that is, its position can't be changed over time—it can be moved to any point in the Extreme 3D world before the object's scale is animated. You can achieve a variety of scaling effects, depending on where the object's center point is.

To animate the scale of an object:

1. **Select the object you want to animate.**
2. **In the current frame field of the animation controls, type the time or frame at which you want the scale to end. Press Enter.**
   Extreme 3D creates a keyframe and calculates the scale animation so it begins at the previous keyframe in the scale track and is completed at the time you specify.
3. **Select the object with the arrow tool and press the F2 (Windows) or Control (Macintosh) key while dragging in the workspace.**
   Dragging toward the bottom of the screen scales objects larger. Dragging toward the top of the screen scales objects smaller.



The fish's scale animating from frame 0 to frame 26.

Note: Objects that are free-linked or ball-joint linked can be scaled independently of their parents. Objects that are lock linked can only be scaled with their parents. Scaling a lock linked child scales the parent and vice versa. For more information, see "Animating with links" on page 253.

Animating with links

Extreme 3D's link tools are a powerful asset to animating. In addition to maintaining the spatial relationships of different parts of a model to one another, they can help animate the mechanical and functional relationships of parts of a model as well. Because each link tool has its own set of linking constraints, each can be used for performing certain kinds of animation.

All links persist throughout the animation. Whenever an object is linked, unlinked, reparented, or changes its link type, Extreme 3D changes the link for the entire animation. For the most predictable results, create all links between objects before you animate them. You can give the illusion of animating links by creating and rendering multiple scenes or by using substitution animation. For more information, see "Substitution animation" on page 284.

Creating animations using parent-child links

Parent-child links establish hierarchical links in which one object's behavior is restricted in some way by its link to the other.

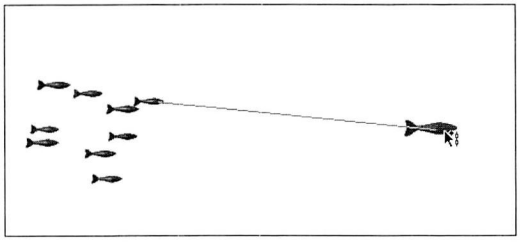
To create a parent-child linked animation:

1 **Choose the link tool that best suits the kind of animation you are creating from the tool palette.**

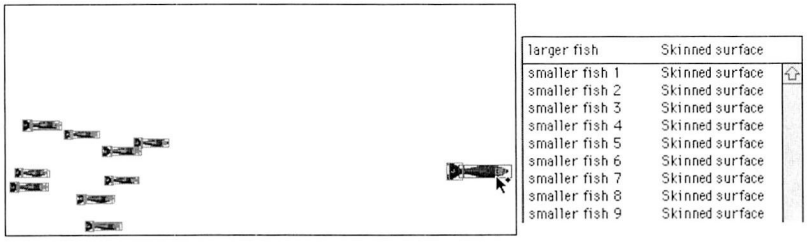
- The position of an object that is free-linked animates as its parent's position changes. However, you can still animate the free-linked object's orientation and position independently of its parent.
- The position of an object that is ball-joint linked animates as its parent's position changes. You can animate the ball-joint linked object's orientation but not its position independently of its parent.
- A lock link creates a symmetric relationship between parent and child. The position and orientation of either object in a lock linked relationship animates as the other's position, orientation, or scale is animated. You cannot animate either the child or the parent independently of each other.

2 **Drag a link line from the object you want to be the child to the object you want to be the parent.**

A parent can have more than one child.



Each child object is linked one at time to the parent object.



The link relationship of the smaller fish to the larger fish is reflected in the selection color of the children in the workspace and in their order of appearance in the World browser.

3 **Choose Animation Controls from the Animate menu to open the animation controls and set the current frame field to the time or frame at which you want your next keyframe.**

4 **Select the parent and move it to a new position in the workspace.**

- For free linked objects, selecting and moving the parent selects and moves the children as well. Children retain all other animation they had before linking, but it becomes relative to the parent. After linking, you can still animate both the position and orientation of the children independently.
- For ball-joint linked objects, selecting and moving the parent selects and moves the children as well. Children retain any orientation animation they had before linking, but all position values they may have had are ignored. After linking, you can still animate the orientation of the children independently.
- In a lock linked relationship, selecting and moving one object selects and moves the other as well. Any orientation or position animation children had before linking is applied to the parent.

5 **Repeat steps 3 and 4 until you have completed the animation you want.**

To see examples of each kind of link being used in an animation:

- For a free link example, choose Open from the File menu, open the file Flinks.E3D and play it.
- For a ball-joint link example, choose Open from the File menu, open the file Bjlinks.E3D and play it.
- For a lock link example, choose Open from the File menu, open the file Llinks.E3D and play it.

Creating a watch-linked animation

There are two roles in a watch link relationship, the watcher object and the target object. The watcher object watches the target object by aligning its positive z-axis to the target object. The watcher object rotates as the target object moves to maintain that alignment. A watcher object can change its position but not its orientation independently of its target object. Watcher objects can have position animation associated with them before the watch link is created. However, you must delete any orientation animation the watcher object might have before you can watch link it to a target object.

If a watcher's positive z-axis is not oriented to the target object you choose, you can use a construction object as the watcher object. Then you can ball-joint link, lock link, or free link the object to that construction object watcher. The object appears to watch the objects that are linked to the construction object watcher.

To create a watch linked animation:

1 **Choose the watch link tool from the tool palette.**

2 **Drag a watch link line from the watcher object to the target.**

3 **Choose Animation Controls from the Animate menu to open the animation controls and set the current frame field to the time or frame at which you want your next keyframe.**

4 **Select the target object and move it to a new position in the workspace.** Selecting and moving the target object selects and reorients the watcher as well.

5 **Repeat steps 3 and 4 until you have completed the animation you want.**

To delete a watch link:

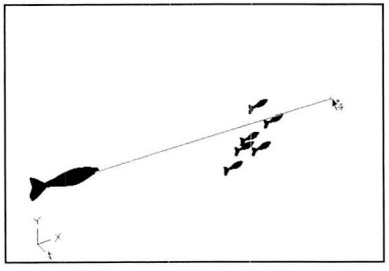
1 **Choose Watch Links from the Window menu.**

2 **Select the watch link you want to delete and click the Delete button.**
The watcher object retains the orientation it has at the time the watch link is broken. If you want the watcher object to be oriented in its original starting position, change the current frame field to 0 before deleting the watch link.

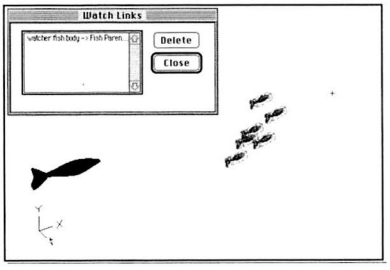
Note: You can animate the target object's position, orientation, or both and the watcher object's position before or after the watch link is created. Also, an object that is watch linked can be free linked or ball joint linked to another object at the same time.

To see an example of the watch link as it is used in an animation:

- Choose Open from the File menu, open the file Wlink.E3D and play the animation.



The smaller fish are animated by a lock link to a construction point. You can make the larger fish seem to watch the smaller fish by watch linking it to the construction point.



The link relationship of the smaller fish to the construction point is reflected in the selection color of the children. The link relationship of the larger fish to the construction point is reflected in the Watch Links dialog box.

Using construction objects as animation aids

Extreme 3D's set of construction objects (the construction point, line, axis, and grid) have some special uses for creating animation. In addition to using them as reference markers in three-dimensional space, you can use them as stand-in objects for quick animation tests, as invisible link parents, and as animation constraints.

Construction objects as stand-ins

Motion blocking and design can be created quickly by setting up your scene using construction points or axes as stand-in objects. Create your animation using these objects. Redraw and playback using construction objects is rapid, allowing movement and timing changes to be made and tested again quickly. When the movement is close to what you want, you can paste or link the real objects to the stand-in construction objects, or copy the construction object's tracks and paste them into the corresponding tracks for the real objects.

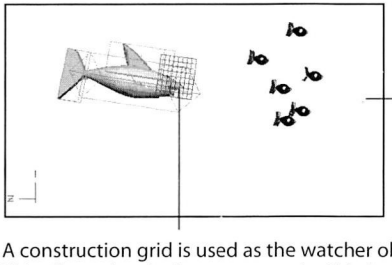
Linking to construction objects

Construction objects can serve as parent objects for any of the linking relationships. Because they don't render in final renders, links to construction objects can be used to quickly animate groups of objects that seemingly have no parent object.

For some links, such as watch links, it is important to know the direction of the parent's axis. Construction axes and grids are most useful as link parents for these links because their orientation in three-dimensional space can be seen in the workspace.

To see an example of construction objects being used as link parents in an animation:

- Choose Open from the File menu, open the file Shark.E3D and play back the animation.

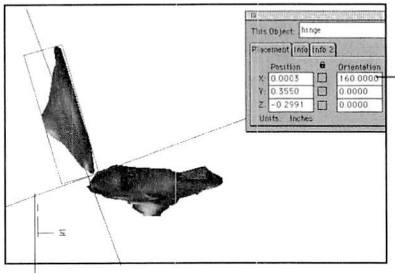


A construction grid is used as the watcher object and the shark is free linked to it. This allows the shark to rotate and still behave as if it is watch linked.

You can also use construction objects as handles to make animating certain movements easier or more intuitive. Depending on the kind of movement you want to achieve, choose a construction point, axis, line, or grid as the parent link.

To see a construction axis used as a link to animate a hinge:

- Choose open from the File menu and open the file Oyster.E3D.



The opening of the shell is animated by changing the orientation value of the construction axis.

The top of the oyster shell is linked to a construction axis.

Creating constraints with construction objects

Use construction lines and grids as points of references in the scene. If you hide objects to speed up playback time, construction lines can serve as references for where those objects are without adding time to the playback. Construction lines or grids can be used to mark places in the scene that objects must hit or avoid as you interactively animate them.

In many ways the ground plane functions like a construction grid. It can be thought of as a stand-in floor, as it never changes position or orientation. By using the Snap to Ground Plane preference, the ground plane can be used as a constraint to keep objects from going through the floor when they animate.

To keep flat objects from intersecting the floor as they animate across it:

1. **Choose Preferences from the Edit menu and click the Geometry page. Check the Snap to Ground Plane check box to turn it on.**
2. **Using the Top view from the View menu, lay out an animation path along the ground plane with the spline tool.**
   The spline points snap to the ground plane grid.
3. **Create the object that will follow this path.**
4. **Position the object at time zero so that it rests on the ground plane.**
5. **Choose the move object center tool and move the object's center to the face of the object that rests on the ground plane, using the 3 key to ensure a 3D snap.**
6. **Choose Convert Profile to Path under the Animation Path option in the Animate menu.**
   The object animates along the ground plane without intersecting it.

To keep objects that move up and down from intersecting the floor:

1 Follow the steps in the previous procedure to lay out the path for the forward movement of the object.

2 Choose Perspective from the Views menu and then choose Orthographic.

3 Position the working plane or a construction grid so that it is perpendicular to the ground plane.

4 Pull the points of the animation path up or down in y space at those places you want up and down movement. Snap the points to the construction grid or working plane.

To keep objects that roll from intersecting the floor, follow the steps for animating flat objects. Then:

1 Create a construction axis and position it at time zero so that it rests on the ground plane.

2 Choose Convert Profile to Path under the Animation Path option in the Animate menu.
The construction axis animates along the ground plane without intersecting it.

3 Free-link the rolling object to the construction axis.

Animating in the score

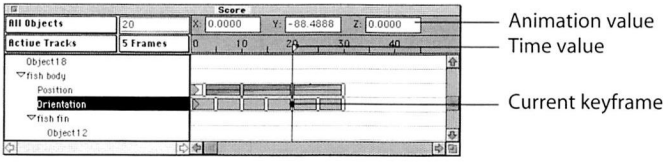
When you animate in the workspace, you can instantly change from animating an object's position to animating its orientation or scale, all while interacting only with the object in the workspace. In the Extreme 3D score the object is represented as a collection of properties. Any changes that you make to an object in the workspace or in any browser—to position, to orientation, or to scale—are stored in the score in the tracks that correspond to these properties of the object. The following sections cover some of these uses of the score, including the following topics:

- Using tracks and keyframes
- Animating properties by changing keyframe values
- Creating a cycle
- Animating object deformations
- Animating visibility
- Animating particle systems
- Animating metaforms
- Fine-tuning animation timing
- Lengthening or shortening a track or an animation

Using tracks and keyframes

The animation information that belongs to properties of objects is represented in the score by tracks. A track stores all the animation information that belongs to a single property. Each track contains all the keyframes for that property. In Extreme 3D the animation values of tracks are stored as curves, not as a sequential list of discrete times or data points. These curves are similar to spline curves in that they have control points—represented by keyframes—and tangent lines at those control points. The tangent lines play a part in how values are interpolated between keyframes and therefore how changes animate.

Each keyframe has two kinds of values associated with it: its ***animation value***, which represents the change in the object's property, and its ***time value***, which represents the moment in the animation at which that change takes place. When you add a keyframe its animation value is determined by the keyframes on either side of it. Its time value is determined by the current time setting. The tangent lines of the keyframe affect the motion style of the animation value and are determined by the tangent lines of the keyframes on either side of it. Tangent lines default to smooth motion style. For more information, see "Modifying the motion style of a change" on page 296.



Note: Most keyframes store a single animation value for the specific time they represent. The keyframes for some properties, however, such as position and orientation, have three values. These represent the object's position or orientation in Extreme 3D's x, y, z world coordinate system at that specific frame of animation. To learn how to create position tracks and keyframes that have a discrete x, y, or z values, see "Simplifying position tracks into x, y, and z components" on page 269.

Understanding and organizing the score list

Names in the score list that are preceded by open/close triangles serve as labels. The scene categories—Objects, Lights, and Materials—and the specific objects, lights, and materials they contain are arranged in hierarchical order in the score list, much as they are in the World browser. You can use the open/close triangles to display this hierarchy. Categories display the specific objects, lights, and materials which, in turn, display the properties associated with each that can be animated. Any name in the score list that has a gray triangle to its right in the track area is the name of a property that can be animated.

To see all the properties that can be animated:

1. **Choose Score from the Animate menu to open the score.**
2. **Choose All Objects from the object filter pop-up.**
3. **Choose All Tracks from the track filter pop-up.**
4. **Click the triangle to the left of the category, object, light, or material whose hierarchy you want to display.**
   By default, the triangles display all the members of an object's hierarchy that match the current track filter.

Once you have created an animation for several properties of several objects, the score filters and open/close triangles can be used together to customize what score information is displayed. This allows you to view only those pieces of animation information that are important to you for your current phase of animation. Selectively displaying items in the score list also increases the speed with which you can work in the score.

Creating and selecting tracks and keyframes

When a property is first changed at any time other than zero, whether the change is made in the workspace or the score, Extreme 3D creates a track and a keyframe for that property at that time. Thereafter, any change to the property adds a keyframe to its track.

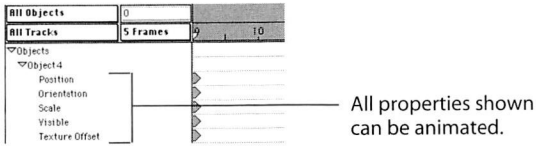
To create a track:

- Make a change to the property at any time other than zero.

To create a keyframe:

1 **Choose Score from the Animate menu to open the score.**

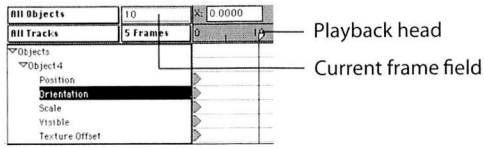
2 **Set the object and track filters to All to expose all the names of properties that can be animated.**



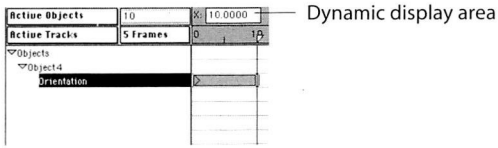
3 **Select the property for the object you want to animate by clicking its name in the score list.**

4 **Set the time or frame at which you want your new keyframe.**
You can do this in the score either by:

- Typing the time at which you want to add a new keyframe into the current frame field.
- Or moving the playback head to the time you want to add a new keyframe.



5 **Enter a new value for the property in the dynamic display area above the timeline.**
In a track that has no previous animation information, two new keyframes are created, one at time zero and one with the value you specify, which is added to the track at the current time. If you are adding a keyframe to the end of track that has already has animation information, only the keyframe at the current time is added.



Occasionally, you might want to temporarily waive the rule that every change made at a time other than zero results in animation information being created. For example, you might want to temporarily rotate an animated object in order to select a control point on its surface that is hidden.

To turn off track and/or keyframe creation:

1 **Choose Animation Controls from the Animate menu to open the animation controls.**

2 **Click the animation toggle so the button pops up.**
The red record light disappears, and changes to any animated object or property do not get recorded as animation information, regardless of the current frame value. When the animation toggle is turned back on, properties that were already animated do not retain any changes you made to them while the toggle was off. Properties that were not animated prior to turning the toggle off retain any changes you made.

The animation toggle on

The animation toggle off

Once you have created some tracks and keyframes, there are a number of ways you can edit and manipulate them. Use object and track filters to focus the score information and facilitate track selection.

To find and select a track:

1 **Choose Score from the Animate menu to open the score.**

2 **Set both the object and track filters to Active.**
This displays all objects and their properties that have been animated and optimizes work in the score.

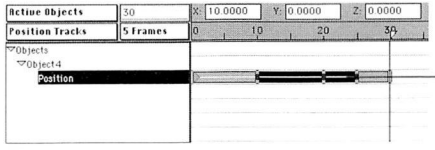
3 **Click the property name under the object's name in the score list whose track you want to select.**
When a track is selected, its entire length and its property name are highlighted and all the keyframes belonging to the track are marked with a vertical red line.

To select a keyframe or range of keyframes:

1 **Choose Score from the Animate menu to open the score and locate the property whose track contains the keyframe you want to select.**
Use the object and track filters to focus your search.

2 **Then, either:**

- Click the keyframe you want to select. (The track that contains the keyframe should not be selected first. If the track is selected, click anywhere in the score to deselect it, then select the keyframe. When selected, a keyframe is marked with a vertical red line.)
- Shift-click the keyframes you want to select. Keyframes must all be on the same track to select a range. When multiple keyframes are selected, the selection range is highlighted. When nonadjacent keyframes are selected, all the keyframes in between the first keyframe and the last keyframe in the range are also selected.



The keyframes at frames 10 and 25 are shift-selected, which also selects the keyframe at frame 20.

Note: All the keyframes in a track are selected when the track is selected by name in the score list.

Editing tracks

You can refine your animation by editing tracks. Track editing includes inserting keyframes anywhere along the track, cutting or copying tracks and pasting them into similar properties belonging to other objects, and deleting single tracks or even deleting all the tracks in your animation. You can also simplify position tracks into distinct x, y, and z tracks to have more control over editing those tracks.

Adding keyframes to a track

Once you have two keyframes in a track you can add more keyframes by inserting them anywhere along the track rather than just appending them to the end.

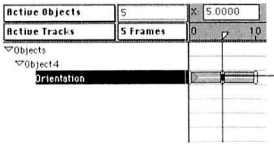
To insert a keyframe in a track:

1 **Choose Score from the Animate menu to open the score.**

2 **Set the time or frame at which you want your next keyframe.**

- Set the current frame field to the time at which you want to add a keyframe.
- Or move the playback head in the score to the time you want to add a new keyframe.

3 **Choose Insert Keyframe from the Animate menu.**
Extreme 3D determines its value by interpolating between the two keyframes adjacent to it.



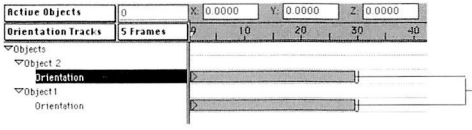
A new keyframe is added to the track at the current time.

Cutting, copying, pasting, and clearing tracks

Tracks can be cut, copied, pasted, and cleared. You can only paste animation information from one track to another of similar type. Information from one position track, for example, can only be pasted into another position track. Copying and pasting tracks is very useful for creating several objects that move in the same way. Segments of tracks and keyframe ranges can also be copied, pasted, and cleared. For more information, see "Editing keyframes" on page 270.

To cut or copy all the animation information of one track and paste it into another track:

1. **Select the track by clicking the name of the property or the name of the object in the score list.**
2. **Select Cut or Copy from the Edit menu.**
3. **Select the entire track you want to paste the animation information into by clicking the name of the property in the score list.**
4. **Choose Paste from the Edit menu.**
   All of the keyframes and each of their values are pasted into the selected track.



The information from Object 1's orientation track has been pasted into Object 2's orientation track.

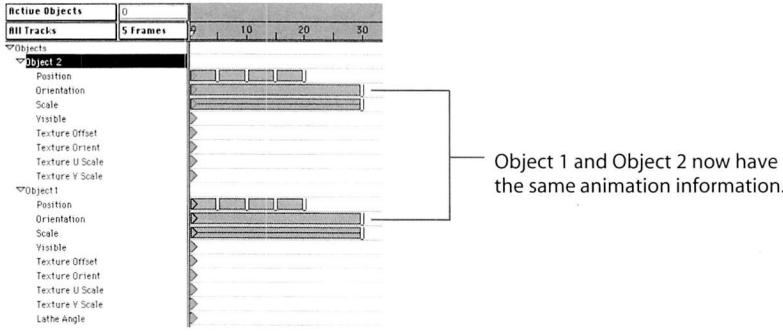
To copy all the tracks of one object and paste them into another object:

1 **In the score list, select the name of the object (not the property) whose animation you want to copy.**

2 **Choose Copy from the Edit menu.**
When an object is copied from the score list, all the properties of the object are copied, except the object geometry.

3 **In the score list, select the name of the object (not the property) you want to paste the animation information into.**

4 **Choose Paste from the Edit menu.**
All the animation information—all the property tracks, all their keyframe values, and any easing information you have applied to keyframe ranges—is pasted into the corresponding tracks of the selected object. Any properties that are not applicable to the selected object are ignored.



Note: When you duplicate an object in the workspace or in a browser after it has been animated, the duplicate object inherits all the track and keyframe information of the original object.

Sometimes you might want to remove all keyframes from a track. For example, when you copy an animated object into a new scene, its animation information is copied as well. However, you might want to animate the object differently in the new scene. If so, you can remove all the keyframes from any of its animation tracks.

To remove all the keyframes from a track:

1 **Select the track in the score.**

2 **Choose Delete (Windows) or Clear (Macintosh) from the Edit menu.**
All the keyframes are removed from the score. If the track filter is set to active, the property name no longer appears in the score list.

To remove all the animation information from an entire scene:

- Choose Clear All Tracks from the animate menu. A dialog box opens that warns you that all animation information will be deleted from the scene and prompts you to confirm this choice.

Simplifying position tracks into x, y, and z components

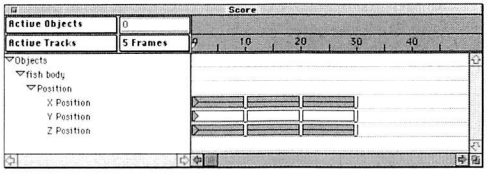
For some kinds of motion it is important to have independent control over the x, y, and z values of the position of an object, rather than having all three values stored in a single keyframe. For example, if you want an object to always remain on the ground, you can simplify its position track. Then you can position the object on the ground at time zero and delete any keyframes in its y position track to ensure that it stays on the ground.

To simplify a position track:

1 **Choose Score from the Animate menu to open the score.**

2 **Select the position track you want to simplify.**

3 **Choose Simplify Position Track from the Animate menu.**
The position property is displayed as a label and three new tracks are displayed beneath it: X Position, Y Position, and Z Position. Each coordinate can have keyframes associated with it at times when the other coordinates do not have keyframes.



Note: Once a position track has been simplified, it cannot be unsimplified and its animation path can no longer be displayed in the workspace as a spline curve.

Editing keyframes

You can refine your animation by editing it at the keyframe level. Using cut, copy, and paste of keyframes you can repeat sections of animation or pass them to other objects. By changing the animation values of keyframes you can fine-tune your movement.

Cutting, copying, pasting, and clearing keyframes

Keyframes can be cut, copied, pasted, and cleared, either as individual keyframes or as a range of keyframes. You can only paste keyframes from one track into another of similar type. For example, keyframes copied from a position track can only be pasted into another position track.

To cut or copy and paste a single keyframe:

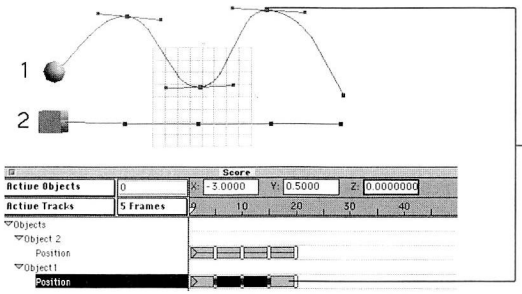
1. **Click the keyframe you want to cut or copy to select it.**
   If you want to see the value of the keyframe you are cutting or copying, drag the playback head in the score to that frame or set the current frame field in the score or animation controls to the frame number of the keyframe. The keyframe value appears in the dynamic display area above the score's timeline. To see the values update dynamically as you drag the playback head in the score, select the track and press the Alt key (Windows) or the Option key (Macintosh) as you drag.
2. **Choose Cut or Copy from the Edit menu.**
   The keyframes animation value is cut or copied. Its time value is not retained.
3. **Click the keyframe you want to paste into.**
4. **Choose Paste from the Edit menu.**
   The absolute animation value of the original keyframe is pasted into the current keyframe, and its tangent lines are adjusted according to the keyframes on either side of it. To confirm the keyframe's new value, drag the playback head in the score to the frame number of the keyframe or set the current frame field in the score or animation controls to the keyframe's frame. The keyframe's new animation value appears in the dynamic display area above the score's timeline.

Tip: To make an animation end at its exact starting point, insert a keyframe at the end time, copy the value at frame 0, select the end keyframe, and paste.

Note: To copy an interpolated value, that is, one not stored in a keyframe, first insert a keyframe at that time. The value you want to copy appears in the dynamic display area. Then copy that keyframe's value.

To cut or copy and paste a group of keyframes:

1 **Shift-click the keyframes you want to cut or copy to select them and choose Cut or Copy from the Edit menu.**
All the keyframes in between the first keyframe and the last keyframe in the range are cut or copied.

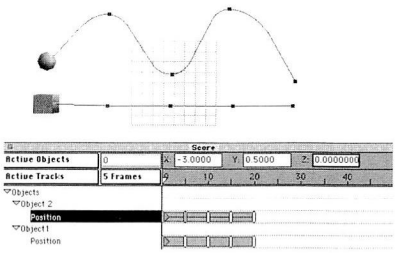


The control points of Object 1's animation path are selected in the workspace because the group of keyframes is selected in the Position track.

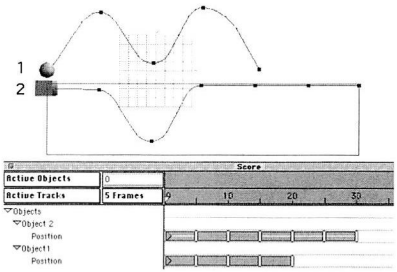
2 **Then, either:**

- Select a single keyframe earlier or later in the track or in the same kind of property track for another object.
- Shift-click multiple keyframes earlier or later in the track or in the same kind of property track for another object to select them.

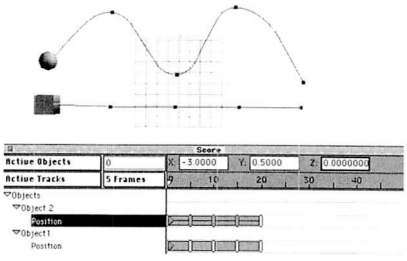
3 **Choose Paste from the Edit menu.**
Extreme 3D performs a paste-replace. That is, it replaces the animation value of the selected keyframe with the animation value of the copied keyframe. If there is more than one keyframe selected, all but the first keyframe are deleted and replaced.The first keyframe selected retains its animation value and its time value.



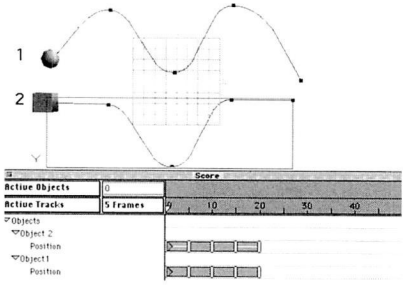
Three keyframes are copied.



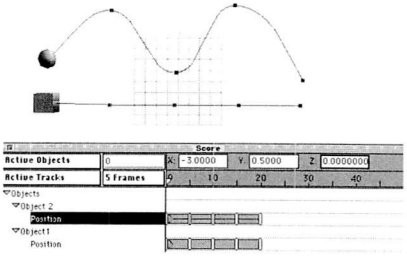
One keyframe is replaced.



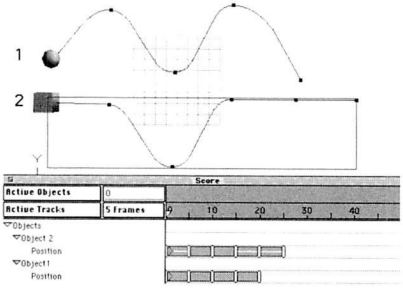
Three keyframes are copied.



Three keyframes are replaced.



Three keyframes are copied.



Two keyframes are replaced.

Note: Multiple keyframes are pasted with values relative to the new track. That is, the copied keyframes adjust their values to fit the track into which they are being pasted. Multiple keyframes for rotations, however, use the absolute values of the original keyframes.

Assigning new values to keyframes

Both kinds of values associated with keyframes—their time values and their animation values—can be changed in the score. In fact, some animation values, for example the animation of lights and materials properties, cannot be edited in the workspace. This section discusses changing both the time values and the animation values of keyframes.

You can assign keyframes new time values by moving them in the track.

To change the time value of a keyframe:

1. **Select the keyframe or range of keyframes whose time value you want to change.**
2. **Drag the keyframe or range of keyframes anywhere along the track within the bounds of the two keyframes on either side of it.**
   Dragging a keyframe or keyframe range assigns it a new time. Dragging a keyframe later in time shortens the amount of time the object has in which to change. This makes the action happen faster. A keyframe at the end of a track can be dragged without limit.

Note: If eases have been applied to the keyframes on either side of a selected keyframe or range of keyframes, the eases are updated accordingly when the keyframes are dragged. You can move the first and last keyframes of an eased range, but you cannot move keyframes within an eased range. For more information, see "Fine-tuning animation motion and timing" on page 296.

If your Display Time preference is set to frames, keyframes automatically snap to whole frame increments when they are dragged. Use the X key to turn frame snapping off. With snapping off, you can drag keyframes to within one-tenth of a frame of adjacent keyframes. This is useful for creating keyframes that affect the final behavior of a property that you do not want rendered as final frames. You can create seemingly instant changes using this method.

To drag keyframes to within one-tenth of a frame of its adjacent keyframe:

- Click the time scale pop-up and choose the 0.2 frame time resolution.

Note: When the Display Time preference is set to seconds, snapping does not apply.

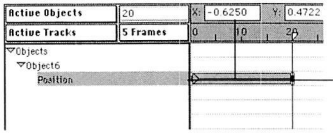
In addition to assigning new animation values to keyframes by moving objects in the workspace, you can also assign them new values directly in the score.

To change the animation value of a keyframe using the score:

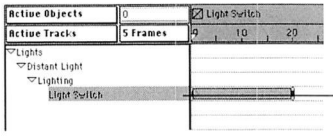
1 **Set the current frame field or drag the playback head to the time at which you want a keyframe value to change.**

2 **Select the keyframe whose value you want to change.**
The entry fields in the dynamic display area become text entry fields, sliders, or color swatches, depending on the property whose track is currently selected.

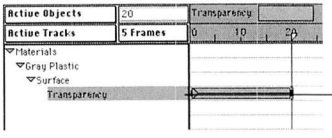
3 **Use the entry field that appears above the timeline in the score to change the keyframe's value.**
Numbers must be entered. Extreme 3D does not accept mathematical expressions as values. However, you can use scientific notation.



Select a position track for an object and change its x value.



Select a light switch track of a light and turn the light on.



Select the transparency track of a material and change its value.

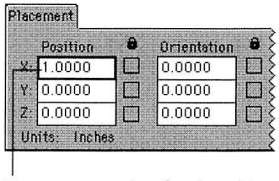
Note: The motion style of your animation may change when you change the animation value of a keyframe. Motion style is determined by the keyframe's tangent lines and those of the keyframes adjacent to it. You can change the tangent lines of a range of keyframes by choosing Change Motion Style from the Animate menu. The default motion style is smooth. For more information, see "Modifying the motion style of a change" on page 296.

Extreme 3D's collection of browsers can also be used to change the animation values of keyframes. The track ball and lock fields in the Objects browser provide extra control for animating movement. The Objects browser also gives you access to an object's mapping type and to its defining geometry. The Lights and Materials browsers are especially useful for making animation value changes to lights and materials properties, as they allow you to preview your changes before you make them.

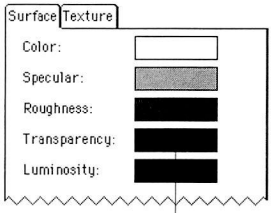
To change the animation value of a keyframe using a browser:

1 **Set the current frame field or drag the playback head to the time at which you want to change a keyframe value.**

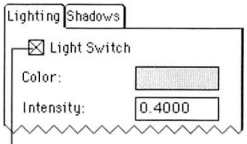
2 **Open the appropriate browser and enter a value in the field associated with the property whose keyframe value you want to change.**
If no keyframe exists for that property at that time, Extreme 3D creates one with the value entered in the browser. If a keyframe already exists at that time, Extreme 3D changes its animation value to that of the value you entered.



Type a new value for the object's x position in the X Position field in the Objects browser.



Change the transparency of a material in the Materials browser.



Turn a light on in the Lights browser.

Note: If you are changing a number of keyframe values, choose Next Keyframe or Previous keyframe in the Animate menu to move to another keyframe whose value you want to change. The Next Keyframe and Previous Keyframe options move the playback head to the specified keyframe in the current track.

Creating a cycle

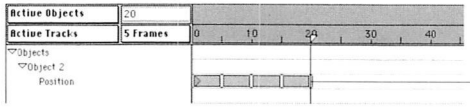
Once you have created a movement you like—the fish swimming through the seaweed, for example—you can *cycle* that animation. That is, you can repeat a segment of animation several times. Using the Repeat Track option, you can create several different types of movement cycles.

Creating a cycle for one object

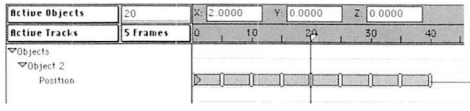
You can create a cycle of animation for a single property of an object without repeating the animation in other property tracks. For example, you can cycle an object's position animation to make it repeatedly move side to side without changing the scale animation that makes it get bigger and smaller.

To cycle the animation in an individual property track:

1. **Select the entire track you wish to cycle by clicking the name of the property in the score list.**
2. **Choose Repeat Track from the Animate menu.**
   This opens the Repeat Track dialog box.
3. **Enter a value in the Number of Times to Repeat text entry field.**
   Entering a value of 2, for example, repeats the animation of that property twice after the original cycle is completed.
4. **Click OK.**



A position track before Repeat Track is applied.



The position track after Repeat Track is applied at frame 20.

To create the effect of ongoing motion, an object breathing or continuously swimming, for example, you can cycle all the properties of an object.

To cycle the animation in all the property tracks of an object:

1. **In the score list, select the name of the object whose animation you want to cycle.**
2. **Follow the steps described in the previous procedure to repeat the cycle of animation.**
   The animation in each of the object's property tracks repeats.

Passing animation cycles to child objects

You can also create cycles for linked objects. Animation of a linked object can be passed down tree to its child objects in two ways. You can either pass the animation of a single property track of the parent to the same property track of the child, or you can pass the animation in all the property tracks of the parent to all those of the child.

To cycle the animation in one property track of the parent object and pass the cycle to the same property tracks of all the child objects:

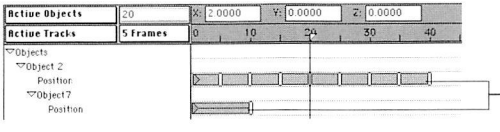
1 **Select the entire track you wish to cycle by clicking the name of the property in the score list.**

2 **Choose Repeat Track from the Animate menu.**
This opens the Repeat Track dialog box.

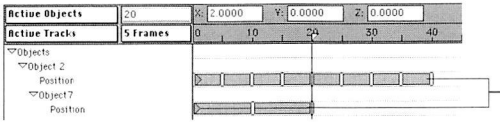
3 **Enter a value in the Number of Times to Repeat text entry field.**
Entering a value of 2, for example, repeats the animation twice after the original cycle is completed.

4 **Check the Repeat Down Tree check box.**

5 **Click OK.**
The animation in the parent object's selected property track and in the same property track of each of the child objects repeats.



Repeat Track applied to the parent's track at frame 20, but not to the child's.



Repeat Track applied down tree to the child's track at frame 20.

To cycle all the animation in all the property tracks of the parent object and pass the cycle to all the property tracks of all the child objects:

1 **In the score list, select the name of the object whose animation you want to cycle.**

2 **Follow the steps described earlier to pass the cycle down tree.**
The animation in each of the parent object's property tracks and in each of the property tracks of all child objects is repeated.

Animating object deformations

You can use Extreme 3D's ability to open and simplify the geometry of objects as a powerful animation technique. You can animate control points directly by moving them in the workspace—called ***vertex animation***—or indirectly by using the free-form deformation tools—called ***deformation animation***.

Vertex animation

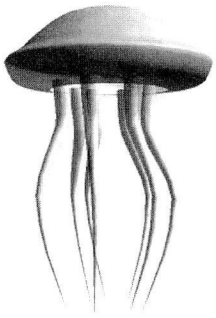
You can display the control points of an object's current geometry level by double-clicking the object in the workspace or by selecting it and choosing Open Geometry from the Object menu. If you open an object's geometry after you first construct it, you see the control points of its defining geometry. If you simplify an object one step to its surface level or, further, to its polymesh level, you see the control points for those geometry levels. You can animate the object's control points at any geometry level using any animation technique. For more information about opening and simplifying geometry see Chapter Three, "Modeling," or the Reference section of the Extreme 3D Help system.

To create a vertex animation:

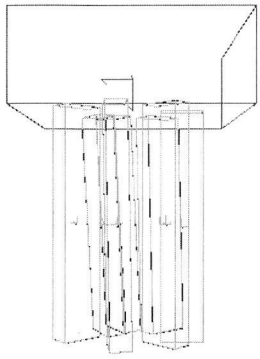
1. **Select the object whose control points you want to animate and simplify it to the level of control you want by choosing Simplify Geometry from the Object menu.**
   Simplifying cannot be undone. Choose the level of simplification for the level of vertex animation you want to do. Don't simplify the object if you want to animate the control points of its defining geometry. Simplify once to animate surface control points. Simplify twice to animate polymesh control points.

2. **Set the object's render style to bounding box by choosing Render Style from the Object menu and then choosing Bounding Box.**
   This step is not essential, but for complex objects with many control points, it can make the profiles and control points easier to see and select.

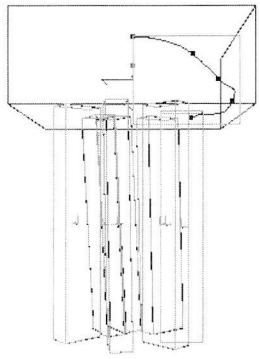
3 **Open the object's geometry by choosing Open Geometry from the Object menu or by double-clicking the object in the workspace.**
This displays the control points for the object's current geometry level. In the case of the jellyfish, the surface control points are displayed.



The object to be animated



The object in bounding box style

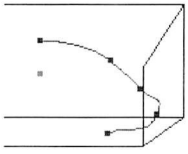


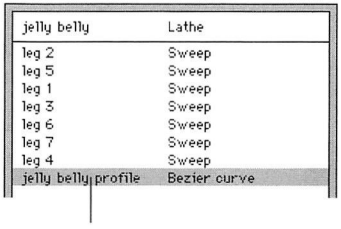
The object's geometry open for editing

4 **Set the current frame field or drag the playback head to the time at which you want to create a keyframe for this profile or control point.**

5 **Then, either:**

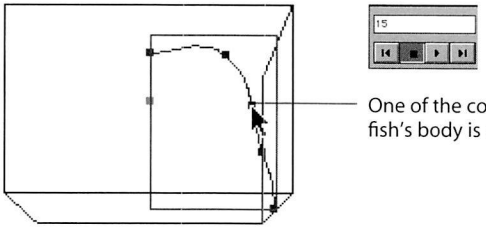
- Choose World from the Window menu to open the World browser and double-click through the hierarchy to the object's geometry. Select by name the profile you want to animate.
- Or, choose the zoom or hand tool and scale the view to help you select the profile or control point you want to animate.



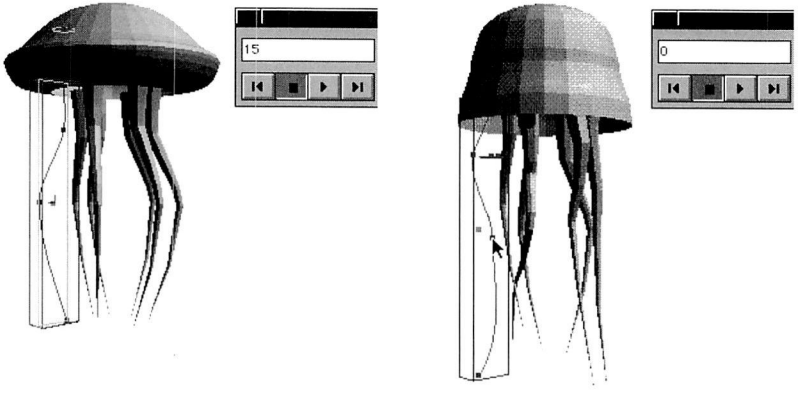


The profile that defines the belly of the jellyfish is selected in the World browser.

6 **Use the score, the Objects browser, the arrow tool and arrow keys, or any other animation technique to animate the profile or control point.**



7 **Repeat steps 4–6 using other profiles or control points until you have the movement you want.**



Steps 4–6 are repeated with control points on the jellyfish's leg.

8 **Adjust any keyframe animation values or time values in the score.**

To see the position of the jellyfish animated and the vertex animation of its body and legs cycled to create the effect of the jellyfish swimming:

- Choose Open from the File menu, move to the Examples folder or directory, and open the file Jellyfish.E3D. Use the animation controls to play the animation.

Free-form deformation animation

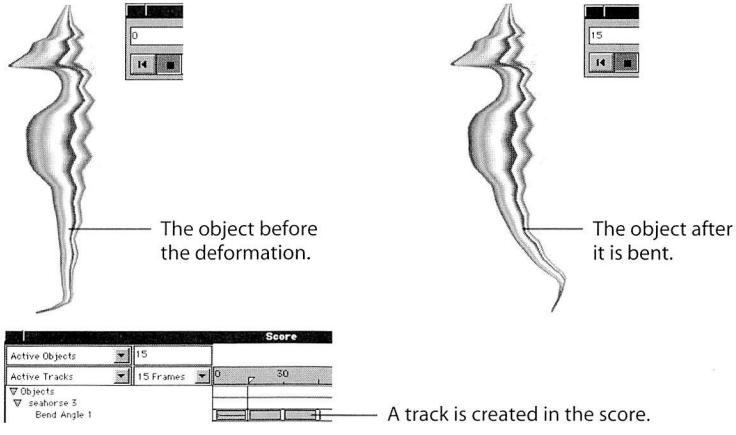
You can animate changes in the shapes of objects using the free-form deformation tools. Choose the deformation tool—twist, bend, taper, stretch, or skew—that best creates the effect you want. Most objects must be simplified at least once to be deformed. Remember that you can either deform the whole object or specify areas of the object to deform. If you specify an area, you can have more control over the deformation by increasing the polygons in that area using Adaptive or Uniform smoothing before you simplify the object or key adding control points in the areas the object you want to deform after simplifying it. For more information about deformations and smoothing, see Chapter Three, "Modeling."

To create a free-form deformation animation:

1 **Select the object whose deformation you want to animate and simplify it by choosing Simplify Geometry from the Object menu.**

2 **Set the current frame field or drag the playback head to the time at which you want the deformation to end.**

3 **Choose the deformation tool that works best for the effect you want to achieve and deform the object.**
Remember to use the deformation tool preferences or define a specific area for deformation to create the deformation you want.



Note: Extreme 3D creates a new track for every deformation you perform. Once a deformation track is created, however, you can modify it by inserting, adding, or deleting keyframes or by using any of the other track or keyframe editing techniques described in "Editing tracks" on page 265 or "Editing keyframes" on page 270.

To see the seahorse deformations animating:

- Choose Open from the File menu, move to the Examples folder or directory, and open the file Seahorse.AVI (Windows) or Seahorse.MOV (Macintosh). Use the animation controls to play the animation.

Animating visibility

By first turning the visibility animation preference on, you can animate the visibility of objects using any of the show or hide options. For most cases it is best to leave this preference off—its default state—so you can show and hide objects without creating animation tracks. When you want to animate visibility, turn the preference on and use layers, the Show and Hide menu commands, the visibility check box in the Objects browser, or the visibility track of objects in the score to animate visibility.

To set the preference for animating of visibility to on:

1. **Choose Preferences from the Edit menu and choose the Animation page.**
2. **Check the Animate Visibility check box.**
   When this box is checked, all show and hide options result in the creation of keyframes on the visibility tracks of objects in the score.

To temporarily turn the animating of visibility off when the visibility animation preference is on:

1. **Choose Animation Controls from the Animate menu to open the animation controls.**
2. **Click the animation toggle.**
   The red record light disappears and no hide or show options create visibility animation tracks. When the animation toggle is turned back on, you can create visibility keyframes again.

Making objects appear and disappear

With the visibility animation preference on you can make objects visible and invisible whenever you want throughout your animation.

To animate the visibility of an object:

1. **Make sure the Animating Visibility Preference is checked in the Preferences dialog box.**
   This preference must be checked when you render an animation that contains visibility animation.

2. **Set the current frame field or the playback head to the time at which you want to animate the object's visibility to off.**

3. **Select an object in the workspace or from the World browser whose visibility you want to animate, or find the object's name in the score list and select its visibility track.**
   If the object doesn't have any animation, set the objects filter to All Objects to expose the object's name. If the object doesn't have any visibility animation, set the track filter to All Tracks to expose its visibility track.

4. **Use one of the visibility options to change the object's visibility state.**
   - Click the Visibility check box in the display field above the timeline in the score.
   - Choose Hide or Show from the Object menu and then choose Selected Object.
   - Choose Objects from the Window menu to open the Objects browser and click the Visibility check box on the Info page.
   - Choose Layers from the Window menu to open the Layers browser, select the name of the object's layer and click Hide or Show to hide or show the layer. For more about using layers, see "Working with layers" in Chapter Three.

Substitution animation

In addition to making objects disappear, visibility animation is useful for creating effects such as instantaneous direction changes and instantaneous object transformations. You can create these effects by using ***substitution animation***. In substitution animation one object is substituted for another object at a specific frame, creating the illusion that the first object instantly becomes the second object.

Substitution animation requires two models. Depending on the effect you want to create, create specific models for the tasks. To make objects instantaneously change direction, create one model and make a mirrored copy. To make an object perform an instantaneous transformation, create two very different models, the "before" model and the "after" model.

To set up a substitution animation:

1. **Set the current frame field or drag the playback head to 0.**
2. **Choose the Free Link tool and link the first object to the second object.**
   The first object becomes the child to the second object. This link is used to align the two objects so they have exactly the same starting point.
3. **Select the first object and choose Align from the Object menu, then choose Both.**
   This aligns the position and orientation of the first object to the position and orientation of the second object.
4. **Lock link the objects and animate them.**
   By lock linking the two objects you can simultaneously create animation for both objects that is completely synchronized.

Once you have created the synchronized animation for both objects, you can create the effect of an instantaneous direction change or an instantaneous object transformation.

To create the substitution animation effect:

1. **Set the current frame field or drag the playback head to 0.**
2. **Set the visibility for the object that appears initially to on.**
3. **Set the visibility for the substitute object to off.**
4. **Set the current frame field or drag the playback head to a time at which you want a substitution to occur.**
5. **Set the visibility for the first object to off and for the substitute object to on.**

Tips for creating substitution animations

- To make one object dissolve into one another, follow the substitution animation steps but animate their material transparencies at the critical frame instead of their visibility. Note, however, that animating visibility is faster to render than animating transparency.
- To create the effect of links that change parent objects during an animation, create two copies of the parent object and two copies of the child object, each pair with its own linking hierarchy. Instead of linking the two parent-child groups, animate one parent-child group and then copy their tracks into the other group. Then create the animating link effect by following the steps for creating a substitution animation.

To see an example of substitution animation:

- Choose Open from the File menu, open the file Shark.E3D and play the animation.

Animating particle systems

The *particle system* tool creates a collection of shapes or polygons that evolve over time. It is useful for simulating phenomena such as smoke, water, or fire. Make the particle collection either by creating a shape and assigning it to the individual particles in a system or by generating single polygon particles at render time. Animate the particles as a group by assigning values to the system's properties such as velocity, gravity, and lifespan.

To create a particle system:

1. **Using any of the modeling tools, create the shape you want each particle in the system to have.**
   All particles in the particle system have the same shape. To create particles with different shapes, create more than one particle system. To generate small single polygon particles at render time, use a construction object or profile as the initial shape.
2. **Select the particle system tool from the tool palette.**
3. **In the workspace, select the shape you created to use as the particle shape.**
4. **Define the particle system's initial position by clicking in the workspace.**
   The new particle system assumes this position and inherits its particle size from the scale of the original object. The original object can be deleted or used as a separate object in the scene. It is no longer related to the particle system object.

In addition to the standard object properties of position, orientation, and scale, a particle system has a number of additional properties. Some of the particle system's properties, such as particle scale, affect the geometry of the shapes in the system. Others, such as velocity, gravity, and drag, apply physical forces to the shapes.

Note: Although Extreme 3D treats particle systems like objects in some ways, there are number of ways in which they don't behave as objects. For example, they can't be deformed, trimmed, or have their geometry opened and closed. Also, unlike other objects, the particle system's scale value affects the size, speed, and position of particles when they are created.

To see all of the properties of a particle system:

1. **Select the particle system in the workspace.**
2. **Open the Objects browser by selecting Objects from the Window menu; look at the Particles, Particles 2, and Particles 3 pages.**
   The particle system has a single object name. You can rename the particle system in the Objects browser.

Because particle systems must exist over time in order to be dynamic, Extreme 3D creates particle systems with default behaviors and sets the Particles On property to on by default. Use the animation controls to see the particle system's default behavior.

To see how the particle system behaves by default:

1. **Choose Animation Controls from the Animate menu to open the animation controls.**
2. **Set the end time to be a value other than 0.**
   Many of the particle system's values are calculated at a per second rate. To get the best idea of what the system is doing, set the end time to a value equal to whole seconds (for example, 90 if your frames per second rate is 30, or 3.00 if you are displaying the score in seconds rather than frames.)
3. **Click the Play button to play the animation.**
   The particle system's default values animate the particles in the system.

Defining a particle system's lifetime

Once you have seen what the system does by default, you can begin to alter the particle system's properties and behaviors to achieve the effect you want. There are two ways to determine how long the particle system exists. The first is to turn the particle system off. The second is to define a time at which particles stop emanating from the system.

To turn the particle system off:

1. **Choose Animation Controls from the Animate menu.**
2. **Set the current frame to the time at which you want to turn the particle system off.**
3. **Open the Objects browser by selecting Objects from the Window menu, then choose the Particles page.**
4. **Uncheck the Particles On check box.**
   When the particle system animates to the frame at which the particle system is turned off, all particles stop where they are and remain as objects in the world.

To define how long the particle system continues to create particles:

1 **Choose Animation Controls from the Animate menu.**

2 **Set the current frame to the time at which you want particles to stop evolving.**
Many of the particle system's values are calculated at a per second rate. To get the most predictable results, choose a frame value that is equal to whole seconds.

3 **Open the Objects browser by selecting Objects from the Window menu, then choose the Particles page.**

4 **Change the Particle Rate to 0.**
When the particle system animates to the frame at which the particle rate is zero, no more particles are created and those particle objects that remain in the world remain only until their lifespan ends.

Each particle in the system also exists for a specified time. Lifespan determines how long each particle exists from the time it is created until it disappears.

To change the lifespan of individual particles at time zero:

1 **Choose Rewind from the Animate menu to rewind the animation to time zero.**
The particle system's default properties and behaviors define the particle system at time zero. Until you are ready to fine-tune the particle system's behavior, it is a good idea to edit the particle system's properties and behaviors at time zero as well.

2 **Select the particle system in the workspace.**

3 **Open the Objects browser by choosing Objects from the Window menu and change the Lifespan value on the Particles page.**
Lifespan units are in seconds and the default for each particle to exist one second. Any positive number is valid.

Most physical simulations, such as those of water, fire or explosion, are achieved by creating particle systems that have many particles. Particle rate determines the number of particles that are created per second. The default Particle Rate value of 10 means that within one second a total of 10 particles are created.

To change the number of particles in the particle system at time zero:

1. **Choose Rewind from the Animate menu to rewind the animation to time zero.**
2. **Select the particle system in the workspace.**
3. **Open the Objects browser by choosing Objects from the Window menu and choose the Particles page.**
4. **In the Particle Rate entry field, enter the number of particles you want the system to generate.**
   A Particle Rate of 90 at 30 frames per second generates 3 particles per frame.

The size of the individual particles also contributes to creating simulations that are believable. For snow, you might want to model the snow flakes at a larger scale, make them smaller than the model at time zero, and have them stay small throughout the animation. By contrast, for boiling water you might want to animate the scale to have the individual particles to start small and increase in size over each particle's lifespan.

To change the size of all particles in the particle system at time zero:

1. **Select the particle system in the workspace.**
2. **Choose Animation Controls from the Animate menu and set the current time to 0.**
3. **Open the Objects browser by selecting Objects from the Window menu.**
4. **In the Particle Scale text field on the Particles 2 page, enter the scale for the particles in the system.**
   The size you enter scales the particles relative to the original geometry used to create the system. When you scale particles at time zero all particles have the size you specify from the time they are created until they disappear.

To animate the scale of particles:

1. **Choose Animation Controls from the Animate menu and set the current time to a time other than zero.**
2. **Select the particle system in the workspace.**
3. **Open the score by choosing Score from the Animate menu, set the filters to Surface Objects and All Tracks, and select the particle system's Particle Scale track.**
4. **Change the Particle Scale value in the text entry field at the top of the score.**
   Now each particle has the beginning scale value when it is created and the ending scale value when it disappears from the system.

Note: The Particle Scale property is different from other particle system properties in that it is relative to the Lifespan property. No matter where in time you place the Particle Scale animation, it applies to the lifespan of each particle.

Creating special effects with particle systems

As with any object, you animate a particle system by changing its properties over time. For a particle system, however, Extreme 3D treats the whole system as a single object and calculates animation for all of the shapes in the particle system using a single set of properties.

Some effects are best created by changing the default values of one or more of the system's properties at time zero, others by changing property values over time. Experimentation is often the best way to achieve the effect you want. Use the descriptions of each property below to inform your experimentations.

For suggestions on creating a typical particle system effect, see the recipe that follows these descriptions.

- **Velocity**—determines the rate at which individual particles move from their creation position to their end position. A particle's starting and ending positions are determined by the whole particle system's position when an individual particle's lifespan begins and ends, and by the effect that other forces, such as gravity and drag, have on the particles.
  - The default value is 1.0. Velocity is measured in units per second and can be any positive number.
  - Particles with a high velocity value move farther in the same amount of time than particles with a low velocity value.
- **Gravity**—affects particle motion by exerting an acceleration force of specific magnitude in a specific direction for a specific duration. The gravity value is multiplied by the time-step and added to velocity to create the acceleration.
  - Gravity is a set of three values that each define a magnitude for one of the coordinate directions: x, y, or z. The default magnitude value for all three coordinates is 0.0. This creates a system in which particles have a constant velocity. The magnitude value for any coordinate is measured in units and can be any positive or negative number. Particles that have a gravity of -10 in Y, for example, move downward with a magnitude of ten, while particles that have a gravity of 10 in X and 10 in Y move upward and to the viewer's right with a magnitude of ten.
  - By animating the gravity value, you can propel the individual particles dynamically. Gravity can either increase or decrease an individual particle's velocity.

- **Source Radius**—defines a two-dimensional circular area from which particles emanate. It lays along the x-z plane of the object. To reorient this plane in world space, change the orientation of the original object at time zero before creating the particle system. To do this, use the orientation fields in the Objects browser or score, or use the trackball in the Objects browser.
  - The default source radius value is 0.0, which creates particles that emanate from a single point. The source radius can be any positive number. It is measured in units.
  - Animating the source radius expands or contracts the source point of the particles. To create an effect such as that of fire spreading, use a small source radius value at time zero and animate to a larger radius.
- **Cone Angle**—determines the angle at which the particles spray out from the source of the particle system.
  - The cone angle defines the particles' degrees of deviation from the system's Y axis and applies it in all directions. For example, a particle system with a cone angle of 360 sprays particles out in all directions from the center, whereas one with a cone angle of 180 sprays particles only upwards and to the sides, not downwards. A cone angle of 0 sprays particles, without deviation, along the Y axis of the particle system. The default value is 40 degrees.
  - Use source radius and cone angle together to create certain effects. Use a larger source radius and a cone angle of 0 to create the effect of a wide area of particles that moves straight upwards, such as the initial explosion of an atomic blast. Use a source radius of 0 and a cone angle of 360 to create the effect of particles that emanate from a single point and radiate in all directions from that point, such as a Fourth of July sparkler.
- **Angular Velocity**—determines how fast particles rotate away from the system's Y axis. This value does not change the particles' trajectory. Rather, it determines if and how fast they spin as they travel.
  - The default value for angular velocity is 0. It represents the particles' degrees of rotation per second.
  - Use high angular velocity, velocity, and cone angle values and a small source radius to create effects such as explosions in which particles shoot and tumble rapidly in all directions from a small source area.
- **Drag**—increases or decreases the velocity of all particles in the system equally.
  - The default value for drag is 0.0, which turns drag off. A drag value of 1.0 means the particles lose all velocity in one second.

- **Randomness**—introduces deviation from the actual values of the velocity, cone angle, lifespan, angular velocity, and drag properties to achieve an increased perception of naturalness or chance.
  - The default value for randomness is 0.01, but any number between zero and 1 can be used.
  - Experiment with animating randomness to create amorphous effects such as steam.

Tip: Until you feel you understand the effect that each force has on the particle system, set the Randomness value to 0.0 at time zero.

To see examples of particle systems animating:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Particle Systems" movies.

To create a fireworks effect:

1. **Create a construction point in the workspace using the construction point tool and follow the steps for creating a particle system using the construction point as the particles' geometry.**
2. **Follow the steps described earlier to set the individual particles' Lifespan to 2.5 and the Particle Rate to 5000.**
3. **In the Objects browser or score, change the Cone Angle to 360 degrees at time zero.**
   This makes the particles shoot out in all directions.
4. **In the Objects browser or score, change the Gravity value to -1.0 in the Y dimension and the Drag to.5 at time zero.**
   The gravity setting causes the particles to fall to the ground (toward the negative Y direction) while the drag setting slows the particles down as they fall.
5. **In the Objects browser or score, change the Velocity to 3, the Angular Velocity to 360 degrees, and the Randomness value to 0.1 at time zero.**
   Increasing the velocity value speeds the particles up. The angular velocity causes the particles to rotate as they fall, allowing the flat faces of the polygons to catch light and sparkle. Randomness makes each particle's velocity and lifespan slightly different, giving the fireworks effect a more natural behavior.
6. **Choose Animation Controls from the Animate menu and set the current frame to 4 if your frame rate is 30 FPS (.8 if you are animating in seconds) and in the Objects browser or score, change the Particle rate to 0.**
   Turning the Particle rate off after the initial burst of particles is created produces the effect of an explosion of particles that die out.

You can finish the effect by applying a material to the particle system and animating the color of material over time. Materials animate on a per particle basis.

To see the fireworks example animating:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Fireworks" movie.

Animating with metaforms

Whole metaform objects can be animated using any of the animation techniques available to all Extreme 3D objects. Create keyframes for the metaform's position, orientation, or scale, or animate its material properties or control points by changing these values at times other than time zero. For more information about creating a metaform object, see "Modeling with metaforms" in Chapter Three.

Animating the whole metaform object

Animating the whole metaform object is no different from animating any Extreme 3D object.

1. **Select the metaform object in the workspace.**
2. **Choose Animation Controls from the Animate menu and set the current time field to the time at which you want the change in the metaform object to be completed.**
3. **Use the arrow tool to reposition the metaform, or use the arrow tool with the F2, F3, or F4 keys (Windows) or the Control, Option, or Command keys (Macintosh) to reorient or scale it.**
   Extreme 3D creates a keyframe for the metaform object in the appropriate track.

As with any other Extreme 3D object, you can animate the position, orientation, or scale of the defining geometry of the metaform as well. To animate the defining geometry of a metaform, open the metaform and select the profile you want to animate.

To open the metaform's geometry:

- Double-click the metaform object in the workspace, or select the metaform object and choose Open Geometry from the Object menu.

When you open the geometry of a metaform object, its control points are available for editing. Moving a control point or its tangent lines at times other than zero is one way to animate the metaform's shape. Another way, one that provides a deeper level of control, is to select and animate the metaform's defining profiles and their properties.

To select the defining profiles of a metaform in the workspace:

1. **Select the metaform in the workspace and open its geometry.**
2. **Choose Render Style from the Object menu, then choose Bounding Box, Wireframe, or Fast Wireframe.**
   All of the metaform's defining profiles are visible and available for selection.

Once the profiles are exposed, you can animate their positions, orientations, or scales.

To animate the position, orientation, or scale of a metaform profile:

1. **Follow the steps for opening the metaform and selecting its defining profiles.**
2. **Choose Animation Controls from the Animate menu and set the current time field to the time at which you want the change in the metaform object to be completed.**
3. **Use the arrow tool to reposition the profile, or use the arrow tool with the F2, F3, or F4 keys (Windows) or the Control, Option, or Command keys (Macintosh) to reorient or scale it.**
   Extreme 3D creates a keyframe for the profile in the appropriate track.

Note: Construction point objects cannot be scaled. To increase their size, increase the blobbiness radius. For more information, see "Animating the shape of a metaform object" on page 295.

You can speed up the animating process by turning off the metaform's default behavior of updating its geometry after every edit.

To turn off updates on edit for a metaform object:

1. **Select the metaform object in the workspace.**
2. **Choose Objects from the Window menu to open the Objects browser.**
3. **On the Metaform page, uncheck the Update on Edit check box.**

To see an example of a metaform animating as a whole object:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Hand" movie.

Animating the shape of a metaform object

Metaforms are especially useful for animating "morphing" effects. By animating the position of a defining profile or control point to be outside the blob radius of other defining profiles in the metaform, you can make the part defined by the profile break away from the rest of the metaform.

Create other shape-shifting or "morphing" effects by animating the blob radius, blobbiness, negative, active, or fill properties for some or all of the defining profiles.

To animate the properties of a metaform profile:

1. **Follow the steps for opening the metaform and selecting its defining profiles, as described on page 294.**
2. **Choose Score from the Animate menu to open the score.**
3. **Set the current time field to the time at which you want the change in the metaform object to be completed.**
4. **Set the score's object filter to Profiles and track filter to All tracks to expose the Blobbiness, Blob Radius, Negative, Active, and Fill properties of the metaform's defining profiles.**
   Although each individual profile has these properties, changing a property for one profile affects the way the whole metaform object looks and behaves.
5. **Select the property track of the profile whose property you want to animate.**
6. **Then use the appropriate text entry field in the score to:**
   - Change the values for the sphere of attraction—Blob Radius—or magnitude of attraction—Blobbiness—for the profile.
   - Check or uncheck the Active check box to make the profile an active or inactive part of the metaform calculation.
   - Check the Negative check box to make the profile's sphere and magnitude of attraction values exert a negative effect on the metaform shape. Use this feature to hollow out areas of the final form.
   - Check the Fill check box to make closed profiles, such as circles or squares, solid, lozenge-like metaforms.

To see examples of metaforms whose properties have been animated:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Drip" and "Cookie" movies.

Note: Metaforms use the projective mapping type. Materials do not map to them if their mapping type is set to intrinsic. Once you have assigned a material to the metaform you can animate it just as you would any other material. For more information about animating materials see, Chapter Five, "Lighting and Materials."

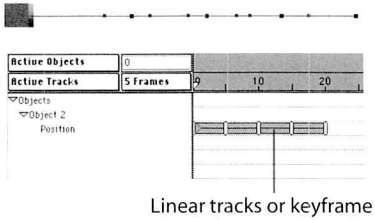
Fine-tuning animation motion and timing

Once you have created an animation, you may want to fine-tune its motion and timing. Extreme 3D lets you modify the motion style of changes, specify how much, if any, acceleration or deceleration occurs at the beginning and ending of a change, and alter the speed at which changes occur between keyframes.

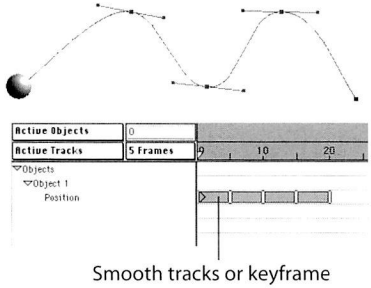
Modifying the motion style of a change

The process of editing the sharpness of the curve of an animation path to change the way the object moves is explained earlier in this chapter in "Changing an object's motion style by manipulating control points" on page 244. Although curves, control points, and tangent lines can only be directly manipulated for an object's position property by displaying the animation path in the workspace, all property tracks—not just position tracks—behave like splines, and all keyframes follow the rules of control points. For all other properties, the way change occurs between two keyframes is manipulated indirectly by changing the motion style of the track or range of keyframes.

The default motion style is smooth. That is, the changes between adjacent keyframes occur like a smooth curve—as if the keyframes have tangent lines that are tangent to the curve and in a line with each other. However, you can change the motion style for any range of keyframes to linear—as if the keyframes have tangent lines tangent to the curve but at angles to each other.



Linear tracks or keyframe ranges have a median line.



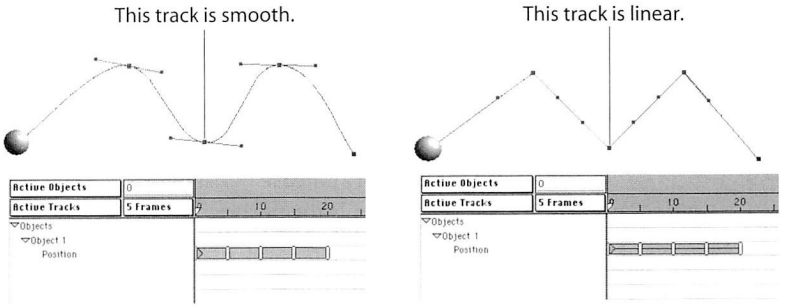
Smooth tracks or keyframe ranges have no median line.

To change the motion style for a range of keyframes:

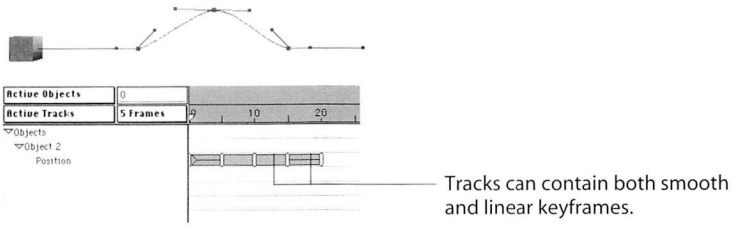
1 **Select two or more keyframes.**

2 **Choose Change Motion Style from the Animate menu and choose Smooth or Linear.**

The new motion style is applied to the entire range of selected keyframes. If it is changed to linear, the range of keyframes is marked in the score with a horizontal median line.



Keyframe ranges along a track can alternate between a smooth motion style and a linear one. Or an entire track can be smooth or linear. The way you want the changes of a property to be animated determines what styles you use and when you use them. Experimenting with motion style can help you determine what is right for the property you are animating.



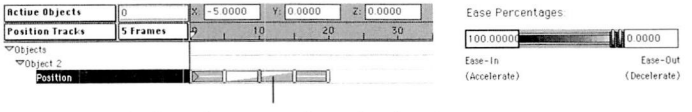
Note: Depending on the number of keyframes in the range and their distance apart in time, changing the motion style of a track or track segment can alter the speed at which change occurs between keyframes.

Accelerating and decelerating change between keyframes

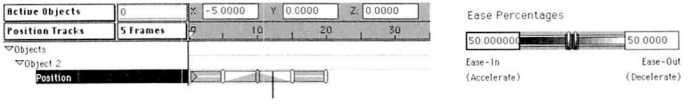
Another way to alter the way change occurs between keyframes is to change its velocity and acceleration. One way to do this is by applying ***easing*** to a track or range of keyframes. Easing in gradually speeds up the change from a point of rest; easing out gradually slows down the change to a point of rest, like a car when you accelerate from a stop and then slow down to stop again.

To create an ease in and ease out over a range of keyframes:

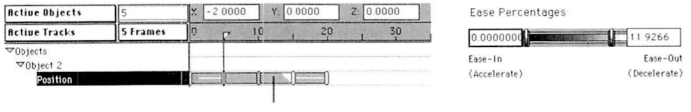
1. **In the score, select the keyframe range over which you want the easing to occur.**
2. **Choose Ease Settings from the Animate menu.**
   The Ease Settings dialog box opens.
3. **Drag the ease in and ease out sliders to set the amount of easing you want.**
   The slider controls the portion of the segment over which easing in or easing out extends.



Gradual acceleration with no deceleration



Moderate acceleration and moderate deceleration



Fast deceleration with no acceleration

When easing has been applied to a range of keyframes, it is visually represented in that track by a gray scale ramp. Once an ease is applied, you can drag the first keyframe and the last keyframe, or the whole keyframe range, but you cannot move keyframes within the ease range.

Sometimes you want changes to happen with constant acceleration, like a ball rolling down a hill.

To create changes that have constant acceleration:

1 **In the score, select the keyframe range over which you want the easing to occur.**

2 **Choose Ease Settings from the Animate menu.**
The Ease Settings dialog box opens.

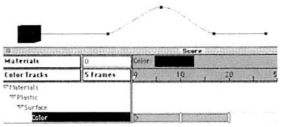
3 **Check the Ease with Constant Acceleration check box to create an ease that maintains constant acceleration.**
Acceleration of the change begins instantly. If, in addition, you specify an ease in or ease out using the slider, the acceleration becomes constant when the ease is completed.

To see an example of easing used in an animation:

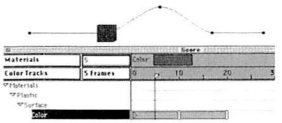
- Choose Open from the File menu, open the file Seahorse.E3D, and play it back.

Creating instantaneous change

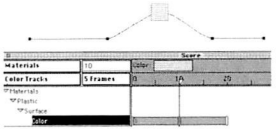
Extreme 3D calculates the change that occurs in a track segment by interpolating the values of the two keyframes that define that segment. You can see what that interpolation looks like when you animate a color change.



At frame 0 the cube color is black.



At frame 5 the cube color is gray, an interpolation half way between white and black.



At frame ten, the cube is white.

Sometimes you want a change between keyframes to happen almost instantaneously. In the example above, you might want the cube to become instantly white instead of interpolating through shades of gray to turn from black to white. If two keyframes that are very close together have very different values, the time over which the interpolation happens between them is very short. The effect is a seemingly instantaneous change.

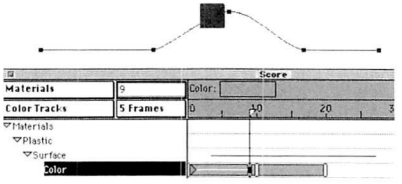
To create a change between keyframes that appears to happen quickly:

1 **Choose Score from the Animate menu to open the score for your animation.**

2 **Select the keyframe at which you want a change to occur very quickly.**

3 **In the current frame field of the score, enter the frame number of that keyframe minus one.**

4 **Choose Insert Keyframe from the Animate menu.**
This creates a keyframe one frame to the left of the frame at which you want an instant change.

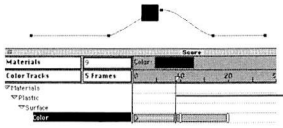


A new keyframe inserted one keyframe prior to the instant

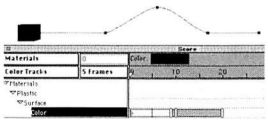
5 **Select the new keyframe and choose Previous Keyframe from the Animate menu.**
The playback head moves to the keyframe to the left of the new keyframe.

6 **Select that keyframe and choose Copy from the Edit menu.**

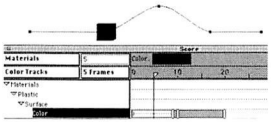
7 **Select the new keyframe and choose Paste from the Edit menu.**
You now have two keyframes at some distance from each other that have the same value and two keyframes very close to each other with very different values.



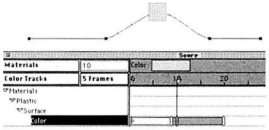
The new keyframe now has the same color as the previous keyframe.



At frame 0 the cube color is black.



At frames 1 through 9 the cube remains black.



At frame ten, the cube is suddenly white.

Note: For some changes to appear instantaneous, you might need to apply an ease in and ease out to the track segment defined by the keyframe at which you want the instantaneous change and at the keyframe you create just before or after it. You might also need to use a linear motion style for the track segments adjacent to this eased range.

You can also create a seemingly instant change between keyframes using substitution animation. For example, to create an instant change in an object's materials, create two objects that are exactly the same but that use different material types. For more information, see "Substitution animation" on page 284.

Scaling and offsetting a track or an animation

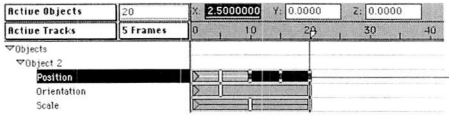
Once you have created some animation you might want to adjust its duration. You can ***scale an animation***—lengthen or shorten it—or ***offset an animation***—move its beginning and ending times. You can apply scales and offsets to a keyframe range, to a single track, to all the tracks of an object, or to all tracks in the scene. All changes to duration must be done with the score open.

Scaling an animation

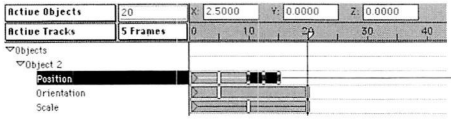
The scaling range is based on the minimum and maximum time values for your animation or for the segment of animation you specify. When you scale the animation of a keyframe range or a single track, the scaling range is based on the times of its first and last keyframe. When you scale all the animation of an object, the scaling range is based on the earliest time and the latest time of all the tracks for that object. When you scale all the tracks of the scene, the scaling range is based on the total length of the animation. Scale values must be positive.

To scale a specific track or keyframe range:

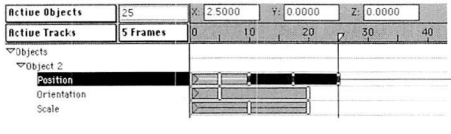
1. **Select the name of the property whose track you want to scale, or select the keyframe range on that track.**
2. **Choose Scale Time from the Animate menu.**
   The Scale Time dialog box opens with the Selected Track Range option on by default.
3. **Enter a scale value.**
   Extreme 3D scales the animation in the selected track by anchoring the left-most keyframe of the selection. When your scale value is less than 1.0, any keys to the right of this keyframe are pulled in. When your scale value is greater than 1.0, any keys to the right of this keyframe are pushed out.



Before the scale is applied, the track segment extends from frame 10 to frame 20.



When a scaling factor of .5 is applied, the track extends from frame 10 to frame 15.



When a scaling factor of 1.5 is applied, the track extends from frame 10 to frame 25.

To scale all the tracks of an object:

- Select the name of the object whose tracks you want to scale and then follow steps 2 and 3 in scaling a specific track or keyframe range.

To scale all tracks of all objects:

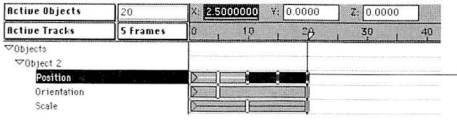
1. **Choose Scale Time from the Animate menu.**
2. **Choose the All Tracks of All Objects option.**
3. **Enter a scale value.**

Offsetting an animation's beginning and ending times

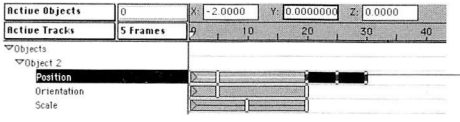
You can change the beginning and ending times of your animation by specifying a number of frames to offset the first keyframe in a range. That offset is applied to the first keyframe and the rest of the track shifts in time to follow the repositioning of the first keyframe. Offset values can be negative.

To change the beginning and ending times of a specific track:

1. **Select the name of the property whose track you want to scale.**
2. **Choose Scale Time from the Animate menu and choose the Apply Scaling To Selected Track Range option if it is not on in the Scale Time dialog box.**
3. **Type the frame number at which you want the animation to begin in the Time Offset text entry field.**
   The beginning time and all the keyframes in the track are adjusted by the offset value.
4. **Enter an offset time.**
   The offset is applied to the first keyframe of the selection, and the rest of the track is shifted in time to follow the repositioning of the first keyframe.

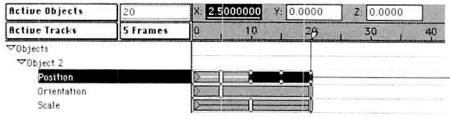


This track extends from frame 10 to frame 20.

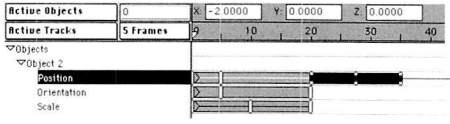


When an offset of ten frames is applied, the track extends from frame 20 to frame 30.

When a track is both scaled and offset, the scaling is applied first.



This track extends from frame 10 to frame 20.



When a scaling factor of 1.5 and an offset of 10 frames is applied, the track extends from frame 20 to frame 35.

To offset all the tracks of an object:

- In the score list, select the name of the object whose tracks you want to offset, then follow steps 2 and 3 from the previous procedure.

To scale all tracks of all objects:

1. **Choose Scale Time from the Animate menu.**
2. **Choose the All Tracks of All Objects option.**
3. **Type the frame number at which you want the animation to begin in the Time Offset text entry field.**

Note: If you want to scale or offset all the tracks of an object or all the tracks of all the objects and one object currently has a keyframe range selected for one of its tracks, you can choose All Tracks of Selected Object or All Tracks of All Objects, respectively, and the selected range is ignored.

Animating the camera

Although there are many ways to view the three-dimensional world of Extreme 3D, the camera provides some special functionality that none of the other viewing techniques has. Most especially, you can animate the camera in Extreme 3D either by animating its view or by animating the camera object. This section covers the following topics:

- Customizing the camera view
- Animating the camera view
- Animating the camera object in the workspace
- Using watch links to animate the camera
- Animating the camera in the score

Customizing the camera view

Extreme 3D opens with a default camera view. By looking at your scene through the default camera view while playing your animation, you can acquaint yourself with the use of the camera. If you plan to render your animation through the camera's view, before you begin animating the camera and its view you need to customize the size of the window that contains the camera view to be appropriate for your final output. You might also want to create an ***establishing shot*** for your scene. This is an initial view from which you begin your camera animation that encompasses the entire scene. It allows your viewers to understand where the action is taking place, what the elements of the scene are and who the characters are.

Assigning the camera view to a window

The first step in working with the camera view is to assign it to a window so you can see what the camera sees. In this regard, the camera view is just like any other view.

To assign the camera view to the current window:

- Choose Views from the Window menu and choose The Camera from the views list. This assigns the camera view to the current window. If you haven't made any changes to the camera view, this view is the default camera view.

To see your animation through the camera view:

1. **Assign the camera view to the current window.**
2. **Choose Animation Controls from the Animate menu to open the animation controls.**
3. **Click the rewind button of the animation controls if the current frame value is not zero.**
4. **Click the play button of the animation controls to see your animation through the camera view.**

Setting the camera window size

In order for the camera to help your animation tell its story, you need to customize the camera view. As with any window, a window containing the camera's view has a specific size assigned to it.

To set the camera view's window size:

1. **Make the window that contains the camera view the current window.**
   You can do this by assigning the camera view to the current window, clicking on the title bar of a window that already contains the camera view, or choosing the window that contains the camera view from the list of active windows at the bottom of the Window menu.
2. **Choose Window Setup from the Window menu.**
3. **Select the size appropriate to your final output from the Image Size pop-up or choose custom and type the appropriate values into the text entry field that appears.**
   The Image Size pop-up provides some guidance as to what window sizes are appropriate for several kinds of output media.

Creating an establishing shot

The next step in creating a customized camera is creating an establishing shot. You can do this using the same tools and commands that you use to change any view. For more about using the basic view tools and techniques, see Chapter Two, "Navigating the workspace."

To set up an establishing shot:

1 **Make the window that contains the camera view the current window.**
See "Assigning the camera view to a window" on page 305 and "Setting the camera window size" on page 306 to insure that the window you are using and the camera view you are creating is useful for your final output.

2 **Use the view tools and commands to set up a view that provides an angle on the scene that is useful to establishing it for your viewers.**

Animating the camera's view

Animating the camera's view is very direct and can be more intuitive than animating the camera object. In many ways, animating the camera view is as easy as changing views using the Views browser, view tools, or preset views. Note, however, that each of the view tools and commands you use to animate the view changes different view properties. Consequently, for some kinds of camera animation, such as pans and tracking shots, animating the camera object can give you more control. For more information, see "Animating the camera object" on page 310.

Animating the camera's view with the view tools

You can use any of the techniques that you use to modify views to animate the camera's view. All changes that you make to the camera's view at any time except time zero create tracks for the camera's properties in the score. To create or check a view at a time other than time zero without creating camera tracks, toggle the animation toggle on the animation controls to off.

To animate the camera's view using the view tools:

1 **Make the window that contains the camera view the current window. If this is your opening camera animation the camera view is displaying your establishing shot.**

2 **Set the current frame field or drag the playback head to the time at which you want the view change to end.**

3 **Use the view tools and commands to create the final view position orientation and scale for this shot.**
For view scales and rotations, use the view tool preferences to set the view's center point at the eye point or look-at point of the view, or at the center of a selected object.

Note: Some view tools and commands animate more than one camera property. See the table "Animation of view properties" on page 309 to see which view properties each of the view tools and commands animates.

Aligning the camera view to another view or object

You can animate the camera's view by aligning it with the position and orientation of another view or with the position and orientation of any object in the scene. Align Camera to View is especially useful setting up the establishing shots of each of a sequence of views. Align Camera to Object is useful for reverse angle shots, as where camera cuts alternate between the points of view of two characters as they interact with each other.

To align the camera with another view or an object:

1. **Make the window that contains the camera view the current window.**
2. **Set the current frame field or drag the playback head to the time at which you want the view change to end.**
3. **Choose Views from the Window menu and select a view from the Views list of the Views browser that you want to use as your camera's view.**
4. **Choose Align Camera from the View menu and choose To View or To Object.**
   When the camera is aligned to a view, it inherits all the position, orientation, scale, and perspective values of that view. When the camera is aligned to an object it inherits that object's position and orientation.

Note: Because the camera view is looking into the scene, its z-axis orientation is the opposite of an object's z-axis orientation.

To animate the camera by creating a series of views:

1. **Choose Views from the Window menu to open the Views browser.**
2. **Create a number of new views.**
   Compose each view as you would for creating an establishing shot. Use the view tools and commands to fine-tune the content of each of these views.
3. **Once you are satisfied with the composition of each view, choose Animation Controls from the Animate menu to open the animation controls.**
4. **Set the current frame to zero.**
5. **In the views list of the Views browser, select the name of the view that you want to use as the camera's initial view.**
6. **Choose Align Camera from the View menu and then choose To View.**
7. **Change the current frame value and repeat steps 5 and 6 to sequence the other views.**

Animation of view properties

		Changes:				
Using this view tool or command:	***With this preference:**	**View position**	**View orienta-tion**	**Scale of camera object**	**View distance**	**Camera center offset**
Hand tool: drag left or right		✔				
Hand tool: drag up or down		✔				
Hand tool: scale	look-at point	✔		✔		
Hand tool: scale	eye point	✔		✔		
Hand tool: scale	center of selected object	✔		✔		
Hand tool: rotate or X-, Y-, or Z-rotation tools	look-at point	✔	✔			
Hand tool: rotate or X-, Y-, or Z-rotation tools	eye point	✔	✔			
Hand tool: rotate or X-, Y-, or Z-rotation tools	center of selected object	✔	✔			
Zoom tool		✔	✔	✔	✔	
Perspective					✔	✔
Fit to Window		✔			✔	✔
Align Camera to View		✔	✔	✔	✔	✔
Align Camera to Object		✔	✔			

* By default, all views rotate and are scaled around the look-at point. The hand tool preferences allow you choose the look-at point, the eye point, or the center of the selected object as the center for rotating or scaling the view when using the hand tool or the view rotation tools.

Because some commands, such as Align Camera to View, animate a number of the camera's properties at once, creating sequential keyframes using these commands may result in an unexpected camera animation. This is because in animating the camera, as in animating any property, Extreme 3D calculates the motion using the shortest distance (or least change). When multiple properties are animating at once, the shortest distance for each change, especially those involving orientation changes, aren't necessarily predictable. See "Animating the camera in the score" on page 322 for suggestions about editing sequential camera keyframes created with the Align Camera commands.

Animating the camera object

By moving the camera's geometry in the workspace, you can animate the same camera properties that you animate using the view tools and commands. Because each camera part can be animated separately, you have greater control over specific camera properties. With this control you can create some camera moves—pans, dollies, tilts, and rolls, for example—with more precision than you can by animating the view.

Finding the camera in the workspace

To animate the camera's geometry you must first show the camera in the workspace.The camera object is always present in the world, but it doesn't necessarily appear in the current view and it never appears in the camera view.

To see the camera object:

1 **Choose Views from the Window menu to open the Views browser.**

2 **From the views list, choose any view except the camera view.**

3 **Choose Show from the Object menu and then choose Camera.**
The camera object appears in the workspace. Use Fit to Window if the Default view still doesn't display the camera object.

Note: If the current view is locked, the Fit to Window commands will not work. Open the Views browser and unlock the view or select another view.

To see both the camera object and the camera view:

1 **Choose Four-View Setup from the Window menu.**
The four-view setup provides Left, Top, Front, and camera views of the scene. When the four-view setup is selected, all other windows are closed. Except for the window containing the camera view, the four-view windows redraw and render only Bounding box and wireframe render styles. This speeds up redraw time and allows you to work more quickly.

2 **If you do not see the camera object in either the Left, Top, or Front views, choose one of those windows, choose Show from the Object menu, then choose Camera.**
The camera object appears in the workspace. Use Fit to Window if the view still doesn't display the camera object

Another way to see both the camera object and the camera view is to:

1 **Create a new window by choosing New Window from the Window menu.**

2 **Choose the Default View from the views list to assign it to the new window.**
Like the Camera View, there is always a Default View that cannot be deleted. Using the Default view, you can toggle through the preset views (Top, Front, Left, and so on) to see the camera object's position relative to the rest of the Extreme 3D world.

3 **If you do not see the camera object in any of the preset views, choose Show from the Object menu and then choose Camera.**
The camera object appears in the workspace. Use Fit to Window if the Default view still doesn't display the camera object.

Animating the camera object's position

You can animate the position of the camera object in the workspace in the same way you animate any object in the workspace.

To animate the position of the camera object:

1. **Choose Animation Controls from the Animate menu to open the animation controls and set the current time to 0.**
2. **Select the camera object and position it in the workspace at the place you want the animation of its position to begin.**
3. **Set the current frame field or drag the playback head in the score to the time at which you want the animation of the camera's position to end.**
4. **Select the camera object and position it in the workspace at the place you want its animation to end.**

Editing the camera's animation path

Just like all other objects in Extreme 3D, the camera object has an animation path that can be edited directly in the workspace, once you have animated its position.

To edit the camera's animation path:

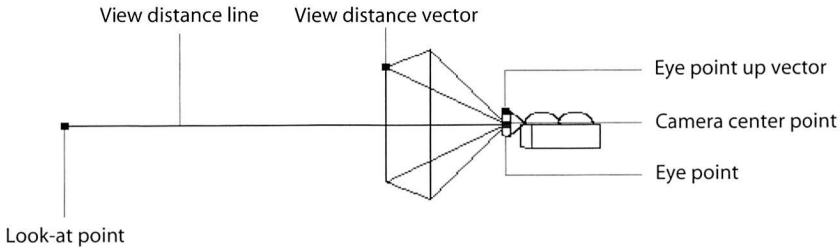
1. **Select the camera object in the workspace.**
2. **Choose Animation Path from the Animate menu, then choose Show to display the position track.**
3. **Double click the path to open it.**
   Its control points are displayed. The path may also be opened by selecting it and then choosing Open Geometry from the Object menu.
4. **Choose the control point tool to add new control points on the camera's animation path.**
   Added points become keyframes. Each control point's place in time is calculated by how far along the animation path the point is added.
5. **Edit the control points to create the shape path you want for the camera.**
   For more information about editing animation paths in general, see "Editing animation paths in the workspace" on page 239.

Opening the camera's geometry to see the camera's control points

Although animating the camera object's position and editing its position path in the workspace is sufficient for some moves, to create more refined camera moves you need to adjust specific parts of the camera. You can have access to specific parts of the camera by opening its geometry.

To open the camera's geometry and display its control points:

- Select the camera object in the workspace and double-click it, or choose Open Geometry from the Object menu.



Animating the camera object's orientation

The orientation of the camera object can be animated like any other Extreme 3D object, by using the arrow tool or arrow keys with accelerator keys, or by using the rotate point or axis tools. Like all other objects, the camera object rotates around its center point. Unlike other objects, the camera's center point can be animated.

By moving the camera object's center point, you can achieve different kinds of camera animation. As a general rule, if you are animating the camera's view, you move the center point of the camera to be coincident with the camera's look-at point. If you are animating the camera object, you want to leave the center point of the camera at its default position of its eye point.

To move the camera object's center point:

1. **Select the camera object in the workspace and open its geometry.**
2. **Choose the move center point tool from the tool palette and move the green center point of the camera to the place you want.**

Performing camera moves using the camera's control points

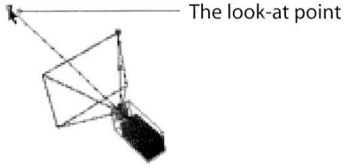
You can create typical film and video camera moves such as pans, tilts, and rolls by using the camera's control points to move the camera object. Before performing these animations you might want to create an establishing shot. Once you have created an establishing shot, find the kind of shot you want to create and follow the steps for accomplishing it.

With a film or video camera, a *pan* is accomplished by turning the head, neck, and arms from one side to another while looking through the camera.

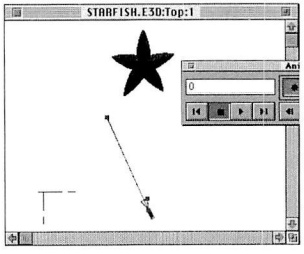
To pan the camera less than 180 degrees with Extreme 3D camera:

1 **Set the current frame field or drag the playback head in the score to the time at which you want the animation of the camera's position to end.**

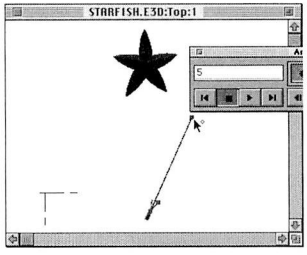
2 **Select the camera and open its geometry. Then select the camera's look-at point with the arrow tool.**



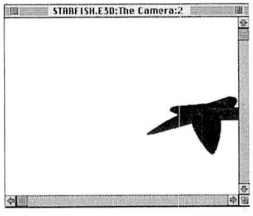
3 **Drag the look-at point in the direction you want to perform the pan. Release the mouse when the final view of the pan shot is framed as you want it.**
When the look-at point is selected, the camera rotates around the eye point.



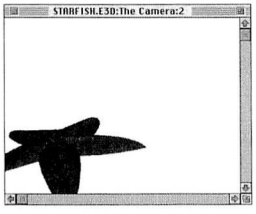
The camera's look-at point is selected,



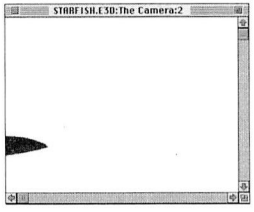
...and dragged in the direction of the pan.



Frame 0 from Camera View



Frame 3 from Camera View



Frame 5 from Camera View

To pan the camera more than 180 degrees with Extreme 3D camera:

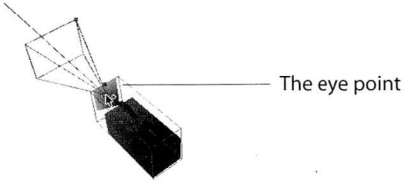
- Follow the instructions in "Creating rotations greater than 180 degrees" on page 251 for performing an auto rotation. Click the Object's Y-axis button to select the axis of rotation and click OK. Extreme 3D calculates the camera pan for you.

A *tilt* is sometimes called a vertical pan. With a film or video camera it is performed by moving the head, neck, and arms in an up-and-down movement from the waist while looking through the camera. Tilts are usually less than 180 degrees.

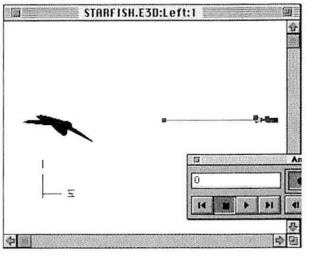
To tilt the camera:

1 **Set the current frame field or drag the playback head in the score to the time at which you want the animation of the camera's position to end.**

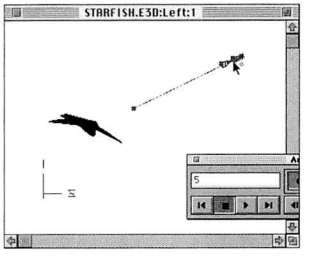
2 **Select the camera and open its geometry. Then select the camera's eye point with the arrow tool.**



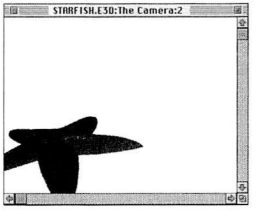
3 **Drag the eye point in the direction you want to perform the tilt. Release the mouse when the final view of the tilt shot is framed as you want it.**
When the eye point is selected, the camera rotates around the look-at point.



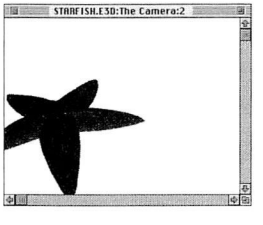
The camera's eye point is selected,



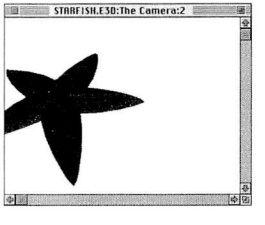
...and dragged upward for the tilt.



Frame 0 from Camera View



Frame 3 from Camera View

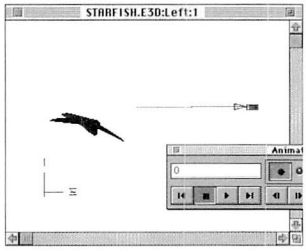


Frame 5 from Camera View

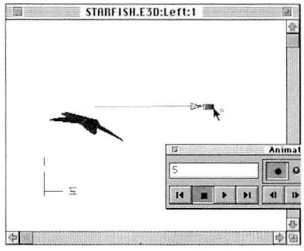
A *dolly* shot is made with a film or video camera by moving the camera in a smooth gliding motion either toward the subject or away from it on a plane perpendicular to it. With film and video camera this move is usually performed with a wheeled vehicle called a dolly.

To dolly the camera:

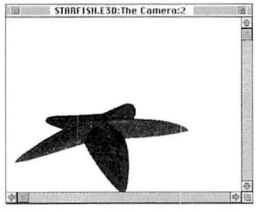
1. **Set the current frame field or drag the playback head in the score to the time at which you want the animation of the camera's position to end.**
2. **Select the camera object itself with the arrow tool.**
   By avoiding opening the camera's geometry, you won't grab one of the camera's control points instead of the camera body.
3. **Drag the camera either towards the object that is your point of interest or away from it. Release the mouse when the final view of the dolly shot is framed as you want it.**
   Using a constraint key constrains the move to one axis and helps you make a smoother camera move. For example, use the H key to constrain movement to the horizontal dimension of the working plane if you are animating the camera from the left.



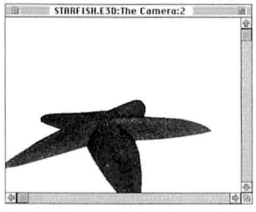
The Camera object is selected,



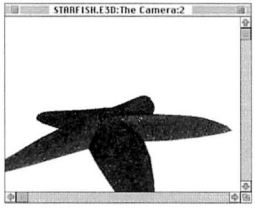
...and dragged toward the point of interest.



Frame 0 from Camera View



Frame 3 from Camera View



Frame 5 from Camera View

Note: After you have performed the dolly, the view distance line may extend past the subject. The subject, however, is still in the camera view. Adjust the view distance only if you want to perform a perspective change as well as a dolly.

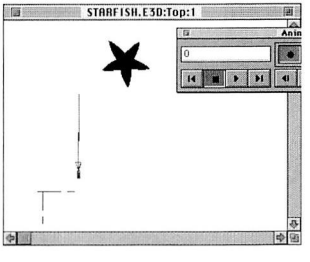
Another kind of dolly shot, sometimes called a *tracking* or *trucking shot*, involves moving the camera in a smooth gliding motion past the subject on a plane parallel to it.

To animate a tracking shot:

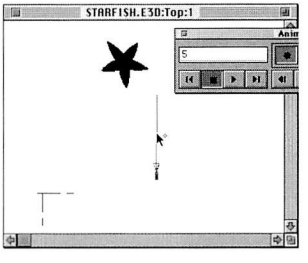
1 **Set the current frame field or drag the playback head in the score to the time at which you want the animation of the camera's position to end.**

2 **Select the camera's view distance line with the arrow tool.**
Use the picture in "Opening the camera's geometry to see the camera's control points" on page 312, if you need guidance about what the view distance line is.

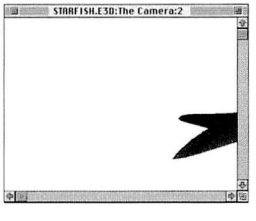
3 **Drag the view distance line (the camera follows it automatically) in a path parallel to the object that is your point of interest. Release the mouse when the final view of the tracking shot is framed as you want it.**
Using the constraint keys—for example, the H key to constrain movement to the horizontal dimension of the working plane if you are animating the camera from the top—constrains the move to one axis and helps make it smooth.



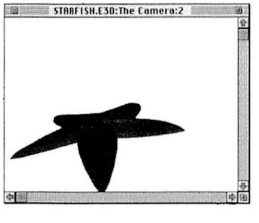
The camera's view distance line is selected,



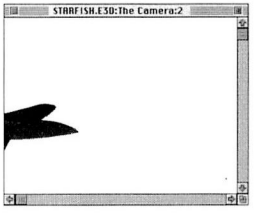
...and dragged parallel to the starfish for a tracking shot.



Frame 0 from Camera View



Frame 3 from Camera View



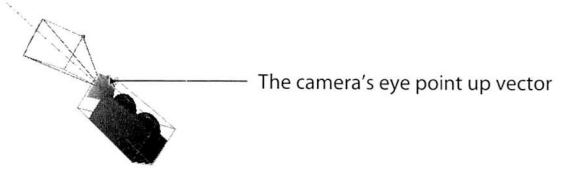
Frame 5 from Camera View

Using a film or video camera, a shot called a *roll* can be performed by rotating the camera in front of your eye. Most camera rolls are less than 180 degrees.

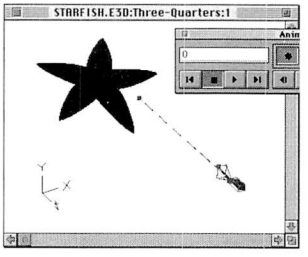
To roll the camera:

1 **Set the current frame field or drag the playback head in the score to the time at which you want the animation of the camera's position to end.**

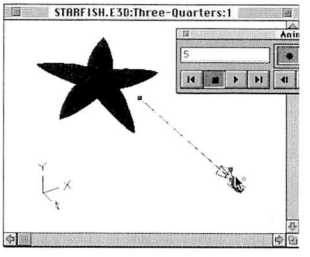
2 **Select the camera and open its geometry. Then select the camera's eye point up-vector with the arrow tool.**



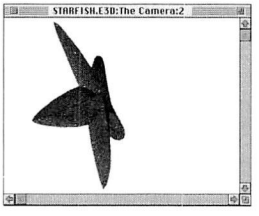
3 **Drag the eye point up vector in the direction you want the roll to be performed. Release the mouse when the final view of the roll shot is framed as you want it.**



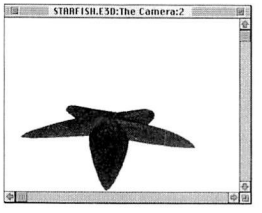
The camera's eye point up vector is selected,



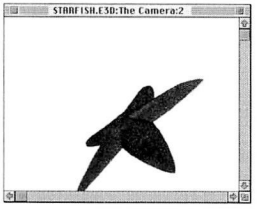
...and dragged in the direction of the roll.



Frame 0 from Camera View



Frame 3 from Camera View



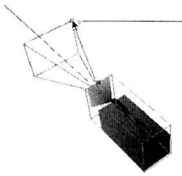
Frame 5 from Camera View

Perspective changes are created in film and video by changing the camera's lenses. Wide-angle and telephoto effects are both created by using different lenses.

To simulate different lenses or to animate a perspective change:

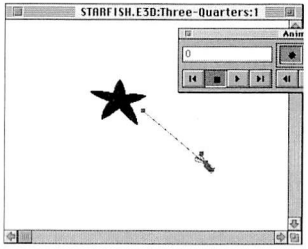
1 **Set the current frame field or drag the playback head in the score to the time at which you want the animation of the camera's position to end.**

2 **Select the camera and open its geometry. Then select the view distance vector with the arrow tool.**

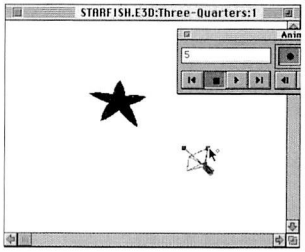


3 **Drag view distance vector towards the bottom of the screen to narrow the perspective or towards the top of the screen to widen the perspective. Release the mouse when the final view of the perspective change shot is framed as you want it.**

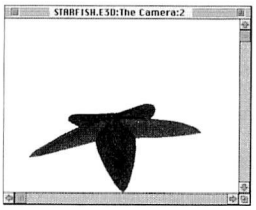
Dragging the view distance vector changes the size of the view perspective pyramid and shortens or lengthens the view distance line.



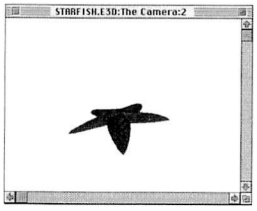
The camera's view distance vector is selected,



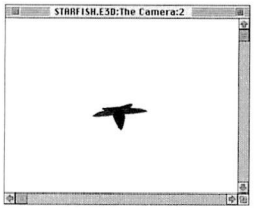
...and dragged downward to widen the perspective.



Frame 0 from Camera View



Frame 3 from Camera View



Frame 5 from Camera View

Using watch links to animate the camera

Another way of animating the Extreme 3D camera is to have it follow the motion of the object that is its interest point. The watch link tool is used to create this effect.

To make the camera follow the motion of an object in the camera view window:

1. **Choose the watch link tool.**
2. **In the workspace, select the object you want the camera to follow while pressing the F3 key (Windows) or the Option key (Macintosh).**
   The camera is watch linked to the object you select. If the camera already has an orientation track, you must clear it before you can watch link the camera to an object.

To make the camera follow the motion of an object in any other view:

1. **Choose the watch link tool.**
2. **Click and drag a watch link line from the camera to the object you want to watch.**

Using a watch link to create a camera fly-through

The watch link can also be used to create a fly-through effect with the camera. This process has two parts.

The first part is to create the camera's animation path as a spline curve in the workspace.

To create a fly through:

1. **Choose the spline tool and draw a spline curve in the world where you want the camera to go.**
   This curve is a regular piece of geometry and can be snapped to other objects.
2. **Choose Animation Controls from the Animate menu.**
3. **Set the current frame field to the last frame of the animation.**
4. **Choose the arrow tool and select the camera object in the workspace.**
   Choose Show from the Object menu and then choose Camera if the camera is not currently displayed. The camera does not appear if your current window contains the camera's view.

5 **Use the arrow keys to nudge the camera very slightly.**
This establishes a position track.

6 **Choose Score from the Animate menu to open the score.**

7 **Select the camera's position track in the score.**
Choose the Object filter called Camera to display the camera and choose either the Active Tracks or Position Tracks filter to display the position track.

8 **Select the spline in the workspace and choose Animation Path from the Animate menu. Then choose Convert Profile to Path.**
The spline curve is now the animation path for the camera.

The second part of creating a camera fly through is to orient the camera to look along the path using a construction point and the watch link tool.

To orient the camera to look along the new path:

1 **Choose the construction point tool and create a construction point in the workspace.**

2 **Select the camera's position track in the score, and choose Copy from the Edit menu to copy it.**

3 **Select the construction point's position track in the score.**

4 **Choose Paste to paste the camera's position track information into the construction point's position track.**

5 **With the construction point's position track still selected, choose Scale Time from the Animate menu.**

6 **Enter an offset value of 2 frames.**
This offsets the construction point's position to be 2 frames ahead of the camera's position.

7 **Choose the Watch link tool, and pressing F3 (Windows) key or the Option (Macintosh), select the construction point in the workspace.**
This watch links the camera to watch the construction point.

8 **Make the camera's view window the current window and choose Play from the Animate menu to check the camera's animation.**

Animating the camera in the score

The score is especially useful for refining the values of keyframes established by animating the camera's view or animating the camera object to perfect the camera's movement.

Note: For information about modifying keyframe animations or time values of camera properties, see "Assigning new values to keyframes" on page 273.

To create a jump cut between camera views:

1. **Choose Animation Controls from the Animate menu.**
2. **Set the current frame value to one before the keyframe at which a view change occurs.**
3. **Select a property track that is affected by the camera view change.**
4. **Choose Insert Keyframe to add an additional keyframe to that track.**
5. **Select the new keyframe and choose Previous Keyframe from the Animate menu.**
   This selects the previous keyframe.
6. **Choose Copy from the Edit menu.**
   This copies the value of the previous keyframe.
7. **Choose Next Keyframe from the Animate menu and choose Paste from the Edit menu.**
   This pastes the value of the previous keyframe into the new keyframe and has the effect of holding one view until the next view replaces it, rather than having values interpolate between the keyframes.

   If the view changes several of the camera's properties, you might need to repeat steps 3 and 4 with the other camera property tracks that are affected by the view change.

Optimizing animation playback

When playing animations in the workspace, you can optimize screen redraw depending on the needs of the current animation task. For example, for simple motion tests, you can preview animation in the bounding box render style, but to see more detail, you can use fast wireframe.

The following table suggests playback options for a few different phases of animation testing.

Animation phase	How to set playback options	Suggested settings
Blocking out timing or designing/testing motion	From the Edit menu, choose Preferences: Animation.	Set Play Animations Using to Bounding Box Render Style.
	Select all objects in the scene and check the Adaptive or Uniform smoothing values.	Set the Interactive values as low as possible.
Checking for intersecting objects during animation	From the Edit menu, choose Preferences: Animation.	Set Play Animations Using to Currently Selected Max Render Style.
	From the Window menu, choose Window Setup.	Set the Max Render Style to Fast Wireframe.
Testing the effect of animated lights	From the Edit menu, choose Preferences: Animation.	Set Play Animations Using to Currently Selected Max Render Style.
	From the Window menu, choose Window Setup.	Set the Max Render Style to Shader.

Notes: If you set the window's Max Render Style to Fast Wireframe, be sure to change it again before rendering the scene. The Final Render to Screen and Render to Disk commands are unavailable when the current window is in Fast Wireframe. For more information, see Chapter Six, "Rendering."

For accurate time-testing of final motion, render the animation to disk as an AVI or QuickTime movie.

5 Chapter Five
Lighting and Materials

Although you can design lights and materials independently of one another, the final rendered look of a scene results from the interaction of lights and materials. By designing your lights and materials together, you can create a wide variety of looks, from very realistic to quite artistic, and have more control over the final rendered look.

Use this chapter with the Lighting and Materials movies that are located in the Learning folder on your application CD. Use the Learning Viewer in that same folder to watch the movies. These movies demonstrate how changes to the properties of lights and materials contribute to the look of the scene.

This chapter covers:

- Using lights and materials together
- An overview of Extreme 3D lights and materials
- Creating lights and materials
- Customizing and managing lights
- Customizing and managing materials
- Animating lights and materials
- Creating global effects
- Settings that affect lighting

Using lights and materials together

Unless your scenes are very simple, you really can't work with materials without working with lights. And although it's easy to put lights into your scenes, you won't know how they're going to influence your scenes unless you have some understanding of how light behaves in Extreme 3D and how certain settings affect how light is rendered.

The following sections describe principles of light in Extreme 3D and how lights and materials interact.

The principles of Extreme 3D lighting

Computer lighting mathematically mimics the physics of light. However, it lacks some of the usual properties of lighting in the physical world. Here are four facts about light in Extreme 3D that differ from natural light.

- Ambient light is not the result of the reflection of light off objects.

  The light that is generated from reflection off objects in the real world is called ***ambient light***. In Extreme 3D you approximate real-world ambient light with an ambient light that shines equally in all directions at all points in the world. Although Extreme 3D allows you to use more than one ambient light, one is sufficient for most scenes.

- All lights *do not* cast shadows.

  In the Extreme 3D world, some lights can cast shadows, others cannot. Even those lights that can cast shadows do so only when you choose that option. You can turn off a shadow for a particular light, or you can turn all shadows off with one setting for purposes of quick rendering. When shadows are off, light passes through objects.

- The intensity of light stays constant over distance.

  In the Extreme 3D world, light illuminates objects near and far with equal intensity, unlike natural light, which falls off in intensity over distance. Although you can simulate distance fall off for omni lights and spotlights in Extreme 3D, distant lights and ambient lights have no fall off.

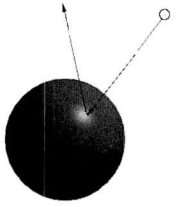
- A light source is *not* an object that can be seen in final rendered images of the scene.

  In Extreme 3D, even those lights that can be represented in the workspace as objects for purposes of positioning do not appear as objects when you render the scene so you can place them anywhere in the scene. For example, you can move a spotlight or omni light next to an object to achieve a brighter highlight, or place a light with a negative intensity in a shadowed area to make the shadows darker.

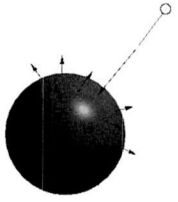
  If you want the light source to be evident, create a model for the light source, such as a lamp or flashlight, and then position the light within that object. You can link the light to the object so the light moves in tandem with the object.

The interaction of lights and materials

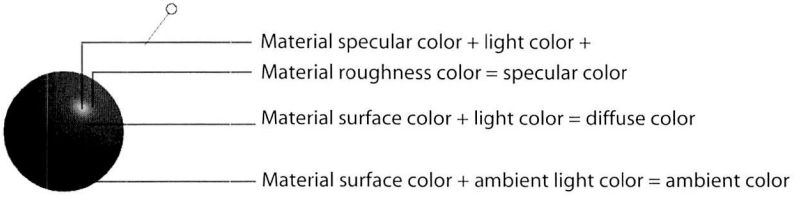
When light strikes a material, some light immediately bounces off the material—this is the specular highlight—and some of the light is first absorbed into the material and then is reflected back out—this is how we see the surface color of the material. In Extreme 3D, this interaction is simulated by the lights and materials properties. By understanding the relationships these properties have, you can adjust their values and predictably design a variety of light and material effects. The following sections discuss how certain properties work together to simulate light.



Light that is directly reflected off the surface creates a specular highlight.



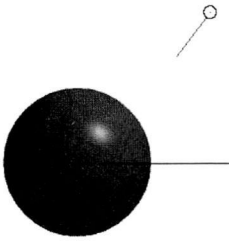
Light that is absorbed into the material before it is reflected creates the color we see. This color is often called the diffuse color, to distinguish it from the specular color.



A material's appearance is the result of a combination of several light and material properties.

Material surface color and the angle of lights

All materials have surface color. This color is set either by the material's ***surface color*** property or a texture map applied to the surface. The surface color that is calculated during rendering is affected by the color of any light that strikes the objects to which the material is applied. In addition, the surface color's hue, saturation, and lightness changes as the angle of any distant, omni, or spotlight changes in relation to the object's surface.



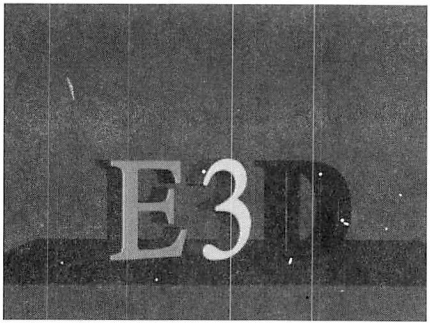
The surface color of a sphere falls off as the surface curves away from the light source.

Material surface and luminosity colors, and ambient light color

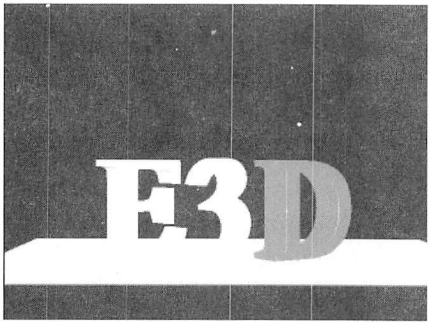
In the real world, ambient light is the light that is reflected off the objects around us. Extreme 3D approximates this effect with ambient lights. The main use of the ambient light is to fill in shaded areas of objects. The color of an ambient light affects the color of objects wherever they are not directly in the light. This effect is especially apparent when you use colored distant, omni, or spotlights.

Because the ambient light is constant throughout the whole scene, it has the effect of reducing the apparent contrast of the surface color of objects in the scene. You can experiment with this contrast to achieve the lighting effect you want by changing the color of the ambient light, or by changing the surface color of each material.

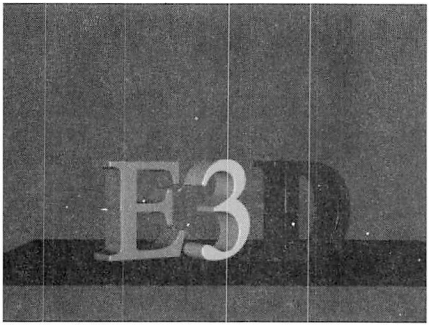
The ***luminosity*** color of a material is the color of light emitted by the object. This can be a different color than the surface color. For example, a gray metal rod with a red luminosity color can emit a glowing red light to simulate heat. Use luminosity to control the effect of the ambient light color on the surface color.



When the ambient light is a dark color, the objects are brighter where they face any distant lights, spotlights, or omni lights, and darker where they face away from any of these light sources.



When the ambient light is a light color, objects have flatter shading.

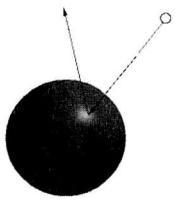


You can change a particular material's response to the ambient light by changing its luminosity color. Here the luminosity for the letters is lighter than it is in the top image.

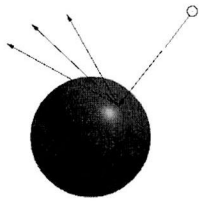
Material specular and roughness properties and the color of lights

Lights can be white or have color. The colors of any lights in the scene can be seen in the highlight of an object. This color is also affected by the specular and roughness colors of the material. If the ***specular*** color of the material is a shade of gray, the highlight is about the same color as the light. When other specular colors are used, the color of each light is scaled by the specular color.

The ***roughness*** color of a material determines whether the highlight is reflected back as a small, hard light, or as a softer, more diffused highlight. Paints that have high gloss, semi-gloss, satin, or flat finishes can be thought of as having different roughness values. For ordinary materials, the roughness color is usually a shade of gray. The darker the roughness color, the glossier the finish and the smaller the highlight. If the roughness is a color other than gray, the specular highlight has a colored halo. This can be used to create certain effects like the reflection of an atmospheric halo around a light.



The light at the center of a highlight bounces off the surface at an angle equal to the angle of the incoming light.



When a surface has roughness, the light around the highlight bounces off the surface at various angles.

Transparency

The ***transparency*** color of a material determines whether or not you can see through the object's surface but does not affect its color. A material that has a transparency color of white produces a surface that you can see through, like glass. A material that has a transparency color of black produces a surface is completely opaque. If an object's material has a transparency color other than black or white, anything behind the object takes on the hue of the transparency color. The transparency property of materials in Extreme 3D also affects the alpha channel of the final rendered image.

An overview of Extreme 3D lights and materials

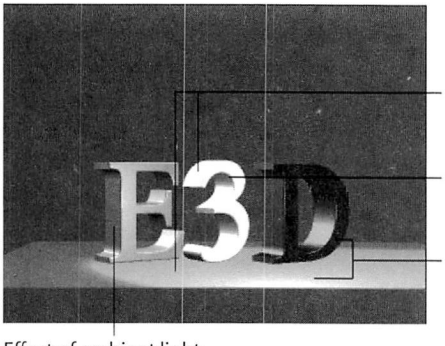
Extreme 3D provides you with four basic light types and eight basic materials that you can edit to produce a variety of effects. By creating instances of these light types and editing their properties, you can create as many lights as you want and add them to your scene. You can also create instances of each of the material types and edit their properties to create a wide variety of materials.

This section discusses the lights and materials types and introduces the main components in Extreme 3D for creating, organizing, and manipulating lights and materials: the *Lights browser* and the *Materials browser*.

The types of lights

There are four default light types that are available in Extreme 3D. They are:

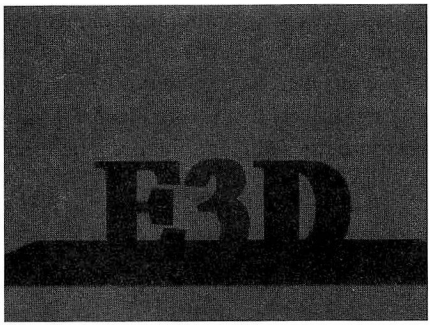
- Ambient lights
- Distant lights
- Omni lights
- Spotlights



This scene uses one of each of the four basic light types.

Ambient light

An ambient light saturates the scene with a pervasive light that shines equally in all directions at all points in the scene. Changing the position or orientation of an ambient light does not change its effect on the Extreme 3D world. Ambient lights are not represented in the workspace by light objects. Ambient lights have the properties of color, intensity, and a light switch.

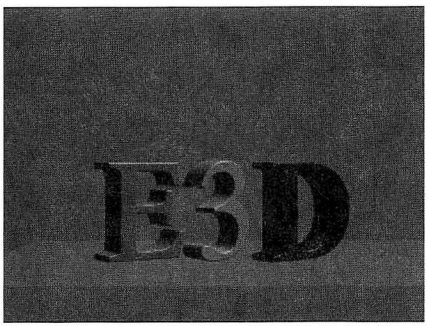


This scene uses just an ambient light.

Note: An instance of the ambient light exists by default in every Extreme 3D scene. You can rename this light or delete it if you do not want to use it.

Distant lights

A ***distant light*** is similar to sunlight. All distant lights point toward the center of the world and shine in a definite direction. Any object surface facing the distant light is illuminated by it. You can change the direction a distant light shines from by changing its orientation and you can define the radius of its source. A distant light shines from infinitely far away, so changing its position does not change its effect on the scene. Distant lights are not represented by light objects in the workspace. The basic properties of distant lights are color, intensity, a light switch, and shadows.

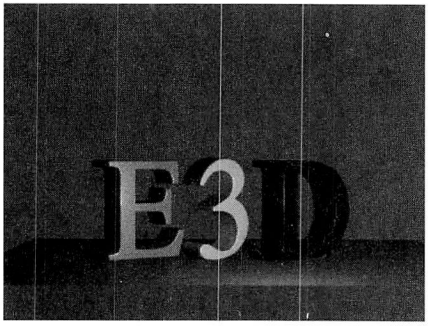


This scene uses just a distant light.

Note: One instance of the distant light exists by default in all Extreme 3D scenes. You can rename this light but you cannot delete it. To keep this light from affecting the scene, use the Light editor to turn it off. For more information, see "Turning lights on and off" on page 352.

Omni lights

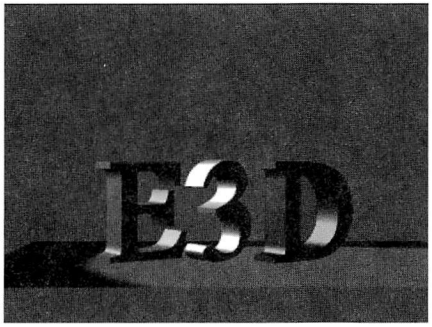
An ***omni light*** is a light that shines equally in all directions (360 degrees) like a light bulb. It has a position in the Extreme 3D world that is represented by a light object in the workspace. Because it shines in all directions, an omni light is not affected by changes to the light pointer or changes in the orientation fields of the Lights or Objects browsers. Set the position of an omni light by value in the Objects browser or interactively by moving its object in the workspace. Omni lights have the basic properties of color, intensity, light fall off, and a light switch. They do not cast shadows.



This scene uses only an omni light.

Spotlights

A ***spotlight*** shines a cone of light from a specific position. Spotlights have a position in the Extreme 3D world that is represented by a light object in the workspace. You can change the direction of a spotlight by using the light pointer or by changing the value in the orientation fields of the Lights or Objects browser. Spotlights have the basic properties of color, intensity, a light switch, shadows, and light fall off. They also have the additional properties of a cone angle (which you can set at various angles up to 60 degrees), cone fuzziness (which you can use to soften the edge of the cone of light), and a variety of dust effects (which you can use to create visible light sources and realistic shadows that prevent lights from penetrating objects).



This scene uses only a spotlight.

The properties of the four light types

Each of the four default light types in Extreme 3D are defined by a set of light properties. The table below shows which properties each of the light types has.

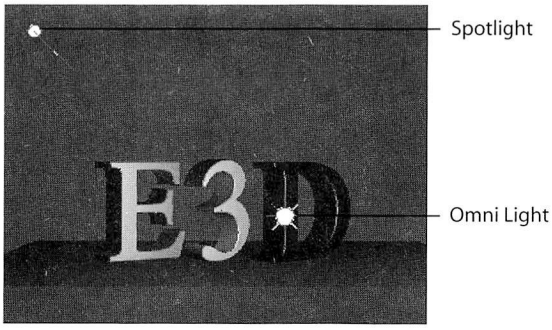
	Light Types			
Light Properties	**Ambient**	**Distant**	**Omni**	**Spotlight**
Position			✔	✔
Orientation		✔		✔
Light switch	✔	✔	✔	✔
Color	✔	✔	✔	✔
Intensity	✔	✔	✔	✔
Shadows		✔		✔
Light fall off			✔	✔
Light cone				✔
Dust				✔

Lights as objects

Two of the four light types are called ***local lights***. Local lights (omni lights and spotlights) are lights that can have positions in the Extreme 3D world. They are represented in the workspace as ***light objects***. Once you have created an omni light or spotlight, you can move it, link it to other objects, and manipulate its light object in the same ways you manipulate any object in the workspace.

Note: Distant lights are very far away, like the sun; Ambient lights are everywhere, like reflected light in the world. Neither distant nor ambient lights are represented by objects in the workspace.

The following figure shows the two icons used to represent omni lights and spotlights as objects in the workspace:



For more about manipulating light objects, see "Editing positions and orientations of light objects in the workspace" on page 350 or "Editing positions and orientations of light objects in the Objects browser" on page 351.

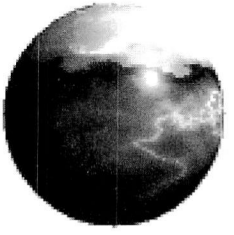
Types of materials

There are eight default material types available in Extreme 3D. Each provides a departure point for customizing new materials that have characteristics similar to those of the default material. These default materials fall into three categories, solid materials, texture map materials, and environment mapped materials. The solid materials are Marble, Organic Magic, Scratched Metal, Stripes, and Tiles. The texture map material is Mondo Map. The Generic+Texture material can be used to create either solid materials or texture mapped materials. Chrome+Glass is the only strictly environment mapped material, although Mondo Map can be used as an environment mapped material.

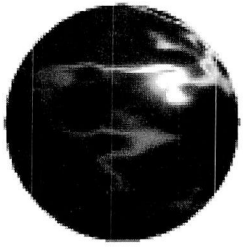
Solid materials

Solid materials are designed to be applied to objects using the projective mapping type. This makes objects appear as if they are carved from solid blocks of material. Each of the solid materials has a set of properties that define the material's color and any of the patterns the material might have. You can use the material orientation tool to reorient solid material patterns. Or scale and offset the pattern with the projective texture placement tool. You can also use solid materials like texture maps by setting an object's mapping type to intrinsic. For more information, see "Choosing a mapping type and placing texture maps on objects" on page 378.

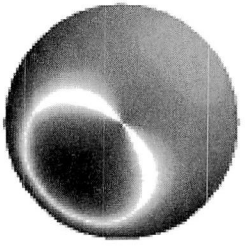
Marble—creates materials with marble-like layers. Use Marble to create stone, marble, water patterns, and other naturally layered looks.



Organic Magic—creates materials that combine two solid materials in semi-random patterns. You can specify how the edges of the surface colors of the two materials blend by editing the material's patterns and properties. Organic Magic is a very versatile material. Use it to create clouds, granite, gasses, sky, and planets.

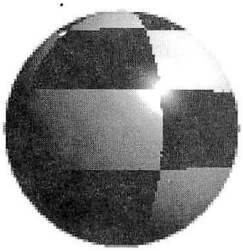


Scratched Metal—creates shiny surfaces with scratch patterns that you specify. The scratch patterns simulate the way light is reflected off different kinds of processed metals. Use Scratched Metal to create machined or lathed metal surfaces or to simulate fabric.

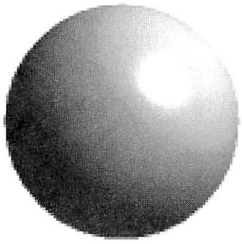


Stripes—creates materials that combine two colors in a pattern of stripes. You can reorient the stripe patterns using the material orientation tool or change the pattern's center with the projective texture placement tool. Use the properties of Stripes to create warps or bumps in the patterns, or to create wood or other layered materials.

Tiles—creates repetitive geometric patterns by combining two solid materials. Use Tiles to create tiled walls and floors as well as other kinds of grids.



Generic+Texture—creates materials that have a single surface color, such as plastic. Experiment with the roughness and transparency properties to achieve a variety of effects from glass to metal that are quick to render. An instance of Generic+Texture, called Gray Plastic, is the default material. It always appears in the Materials browser and can be changed but not deleted.



Note: Use the projective mapping type for objects to which you apply solid materials. To use solid materials like texture maps, set the object's mapping type to intrinsic. For more about texture mapping see "Using texture maps" on page 375.

Texture map material types

Texture map material types apply bitmapped images to an object's surface. Objects to which texture map materials are applied use the intrinsic mapping style as their default. This conforms the image map to the contours of the object's surface. Scale or offset maps with the intrinsic texture placement tool, or tile them using settings in the Objects browser.

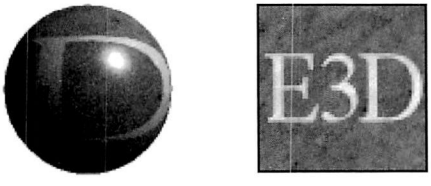
Texture maps can be applied to objects that use any of the other mapping types. Use the Objects browser to choose a mapping type other than intrinsic mapping. On objects that use non-intrinsic mapping types, you can reorient the texture map on the object's surface using the material orientation tool. Or, you can change the origin of the map relative to the object you are mapping by using the texture map placement tool that corresponds to the object's mapping type. For more information, see "Choosing a mapping type and placing texture maps on objects" on page 378.

Using Mondo Map, you can use bitmap images rather than solid color to define the material's surface, specular, roughness, luminosity, and transparency colors. You can also use texture maps to create bumps on an object's surface. Use the Default Mondo Map material to create complex surfaces.

This material is composed of a color map, a specular map, and a roughness map.

This material is composed of a luminance map, a bump map, and a transparency map.

Use the texture map feature of Generic+Texture material to create a surface texture from a single bitmapped image. This material is very useful for creating labels, wallpaper, or other surfaces that need to render quickly.

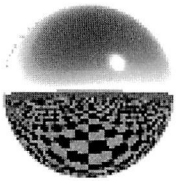


Generic+Texture uses a single texture map to define an object's surface.

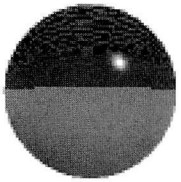
Environment mapped materials

Texture maps can also be used as ***environment maps***. You can think of an environment map as a backdrop to your scene that is reflected off the surface of the material. Use Chrome+Glass or Mondo Map to create reflective materials and then use an environment map to reflect in those materials.

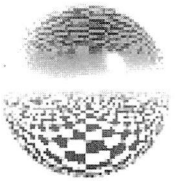
Chrome+Glass—creates materials that can be either reflective, like metal, or refractive, like glass, or both. Environment map materials take most of their color from the environment map that you assign to it. You can use Chrome+Glass to create surfaces such as polished chrome, gold, copper, and colored or clear glass.



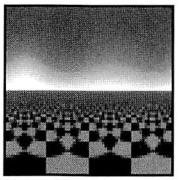
Chrome



Glass



Chrome and Glass



All three materials reflect this environment map.

By first using its specular and roughness properties to create a highly reflective surface, you can also use Mondo Map as an environment mapped material.

A specular and a roughness map create a reflective surface that reflects the environment map.

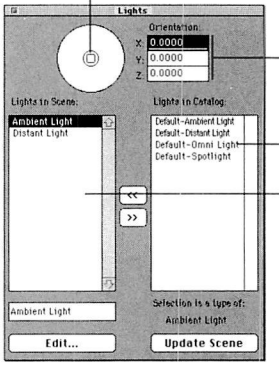
For more information about each of these material types and the kinds of surface looks you can achieve by customizing each, see the Extreme 3D Help system. For information about how to use the default materials and texture maps, see "Customizing materials" on page 367 and "Using texture maps" on page 375.

The Light and Materials browsers

The Lights and Materials browsers display the list of lights or materials in the current scene and the types of each that are available from the current catalog. Use the browsers to open the appropriate editor and create a new light or material.

To open the Lights or Materials browser:

- Choose Lights or Materials from the Window menu.

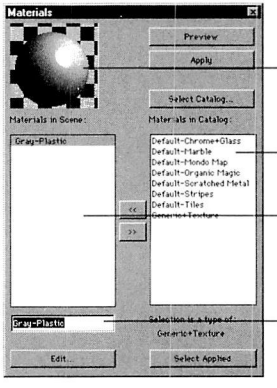


Lights pointer

Orientation text entry field

Lights in Catalog list

Lights in Scene list



Preview window

Materials in Catalog list

Materials in Scene list

Name text entry field

In either browser, the Catalog list shows the complete list of light or material types available in the current catalog. The default Lights catalog list contains one each of the four default light types available in Extreme 3D. The default Materials catalog list contains one each of the eight default material types available in Extreme 3D. The catalogs are stored in the Scripts folder inside the Extreme 3D application folder.

The Scene list of either browser shows the lights or materials that affect the current scene. When you first open Extreme 3D, the Scene list of the Lights browser displays two lights, called Ambient Light and Distant Light. Both lights are present in all scenes and can be edited or turned off and on like any other light. The Ambient Light can be deleted from the Scene list but the Distant Light cannot. Initially, there is one material in the Scene list of the Materials browser, called Gray Plastic. This is the default material that is applied to all objects when you first build them. It is an instance of Generic+Texture. Gray Plastic can be edited but not deleted from the Scene list.

The Edit button in either browser opens an editor that displays the properties for the light or material currently selected in the Scene list. Use the ***Light editor*** to edit lights' properties and create customized lights. Use the ***Material editor*** to create and customize materials. You can also double-click any light or material name in the Scene list to open the appropriate editor.

In the Lights browser, the light pointer and orientation text entry fields let you change the orientation of any distant light or spotlight. Drag the light pointer or type a value in the orientation text entry field to change the orientation of the selected light. The Update Scene button lets you see how the changes you make to lights affect the scene.

The Preview button of the Materials browser lets you see the current material as it is applied to the object in the Preview window. The Apply button in the Materials browser applies the material to any object that is selected in the workspace.

Note: The Preview window in the Materials browser uses the current light settings in your scene to calculate the material preview.

Creating lights and materials

The processes you use to create lights and materials are similar. Consequently, you can switch from working with lights to working with materials easily. In fact, designing a scene with the desired atmosphere and details is a process of switching between lights and materials, and adjusting positions and values until you achieve the effect you want.

There are several ways to add new lights or materials to your scene. Some of these ways include:

- Using the Lights or Materials browser
- Using the World browser to copy or duplicate lights and materials or light objects
- For omni and spotlights only, copying or duplicating light objects directly in the workspace

In order to see the effects of lights and materials as you add and edit them, it's a good idea to perform test renders as you work. Although you can get a general idea of how a scene will look as you set it up, the interactive renderer (which is always active until you specify a final render) only approximates the scene. Some lighting and materials effects won't appear until you perform a final render of the scene.

To render a single frame to the screen using final render settings:

- Choose Final Render to Screen.

Using the Lights and Materials browsers

With the Lights and Materials browsers you can create new lights or materials in one of two ways. You can add lights or materials to the scene from the Catalog lists and you can copy or duplicate existing lights or materials in the Scene lists.

Adding lights and materials to the scene

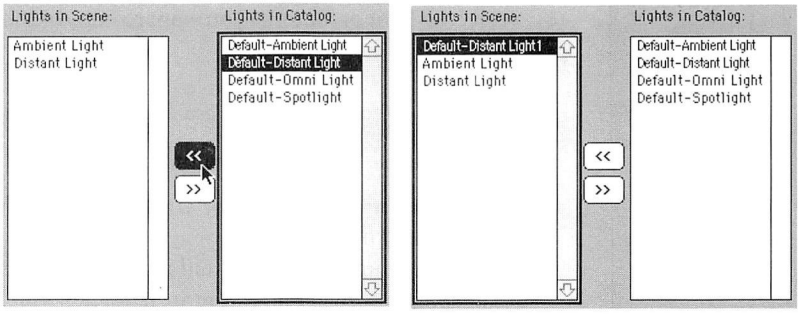
Any of the four default light types or eight default material types can be copied from the Catalog list to the Scene list to add a new light or material to the scene.

To add a light or materials to the scene from the Catalog list:

1 **Choose Lights or Materials from the Window menu to open the appropriate browser.**

2 **Select the light or material type you want in the Catalog list.**

3 **Click the load button or double-click the light or material name.**
An instance of that light or material type appears in the Scene list.



4 **Rename the new light or material by typing in the text entry field below the Scene list and pressing Enter.**

5 **Click Update Scene to redraw the scene in the workspace using the new light, or click the Preview button to preview the look of the new material using the current light configuration.**

- For omni lights and spotlights you may first want to position the new light's object in the workspace or by value in the Objects browser. For more information, see "Editing light objects" and "Editing positions and orientations of light objects in the Objects browser" on page 351.
- For distant lights and spotlights you may need to adjust the new light's orientation with the light pointer before updating the scene so you can see the effect of the light.
- When you add a new spotlight or omni light to the scene, it appears at the center of the world and may be obscured by geometry. Hide geometry objects or create a lights layer and make it the current layer before adding new lights to more easily select new spotlight or omni light objects in the workspace.

Copying and duplicating lights and materials

Once you have added lights or materials to a scene, you can create new ones by copying or duplicating those in the Scene list of the Lights or Materials browser.

To copy or duplicate a light or material in the Lights or Materials browser:

1. **Choose Lights or Materials from the Window menu to open the appropriate browser.**
2. **Select the light or material you want to copy in the Scene list.**
3. **Then, either:**
   - Choose Copy and then Paste from the Edit menu.
   - Or choose Duplicate from the Edit menu.
4. **Rename the new light or material by typing in the text entry field below the Scene list and pressing Enter.**
   Copied and duplicated lights and materials inherit all of the values of the original light or material, except its name.
5. **Click Update Scene to redraw the scene in the workspace using the new light or click the Preview button to see how the new material looks in the preview window using the current light configuration.**

You can check the property values that the new light or material has inherited using the Light or Material editor.

To see the property values of a light or material:

1. **Select the name of a light or material in the Scene list.**
2. **Click the Edit button.**
   The Light or Material editor opens, displaying the properties available to the current light or material and the specific values set for them.
3. **Click OK to close the editor.**
   Cancel restores the light or material to its previous state without applying any changes.

To refine the new light or material, you might want to edit some of the light or material properties. For more information, see "Editing light objects" on page 350 or "Applying materials" on page 365.

The Light and Material editors are also used to customize lights and materials. For more information about customizing lights and materials properties see "Customizing and managing lights" on page 350 and "Customizing and managing materials" on page 365.

Using the World browser to create new lights and materials

You can use the World browser to create lights and materials that are duplicates or copies of existing lights or materials. Copied or duplicated materials inherit the original material's property values. Lights can be copied or duplicated either as light properties or as light objects in the World browser.

Copying and duplicating lights and materials in the World browser

This process is similar to copying and duplicating lights or materials in the Lights and Materials browsers, except you need to navigate through the world hierarchy to get to the appropriate list.

To copy or duplicate a light or material in the World browser:

1. **Choose World from the Window menu to open the World browser.**
2. **Double-click the top item in the World browser list until World is at the top of the list.**
   Double-clicking the top level name navigates you through the world hierarchy.
3. **Double-click Lights or Materials in the hierarchy list under World.**
   The names of the lights or materials in the current scene are listed.
4. **Select the name of the light or material you want to copy or duplicate.**
5. **Then, either:**
   - Choose Copy and then choose Paste from the Edit menu. The copy has the same name as the original.
   - Or choose Duplicate from the Edit menu. The duplicate has the same name as the original but has a number appended to it.

   Copied and duplicated lights or materials inherit all of the values of the original, except its name. The next time you open the Lights or Materials browser, you can see the new light or material listed in the Scene list.
6. **Name the new light or material by typing in the text entry field below the world hierarchy list and pressing Enter.**

To preview the new material or light:

1 **Choose Lights or Materials from the Window menu to open the Lights or Materials browser.**

2 **Click Update Scene to redraw the scene in the workspace using the new light or click the Preview button to see how the new material looks in the preview window using the current light configuration.**

Copying and duplicating light objects in the World browser

You can also use the World browser to copy or duplicate a light as an object. In addition to inheriting all of the property values of the original light, lights that are copied and duplicated as objects in the World browser also inherit the position and/or orientation of the original light.

To copy or duplicate a light object in the World browser:

- Follow the instructions in "Copying and duplicating lights and materials in the World browser" on page 347, except in step 3 navigate to the Object list and select the light object you want to copy. Then proceed with the remaining steps. The new light is entered in the Lights hierarchy list.

Creating light objects in the workspace

Once you have one light object in the workspace, you can create a new light by copying or duplicating it. By default, lights that are copied or duplicated in the workspace inherit all of the values of the original light including its position and/or orientation in the Extreme 3D world. You can, however, specify a new position for a pasted light object by using construction objects.

Copying and pasting a light object in the workspace

Copying and pasting light objects in the workspace is similar to copying and pasting any other object.

To copy a light object in the workspace:

1 **Choose the arrow tool and select the light you want to copy in the workspace.**

2 **Deselect the light object in the workspace.**
As with other objects, the copied light will replace the original when you paste if you don't deselect it first.

3 **Choose Copy and then choose Paste from the Edit menu.**
The new light is pasted into the workspace in the same place as the original light.

Specifying a position for pasted light objects

You can use the paste-replace behavior of Extreme 3D to paste light objects at any location in the scene.

To paste the new light at a specific place in the workspace:

1. **Use the arrow tool to select the light in the workspace, then choose Copy from the Edit menu.**
2. **Choose one of the construction object tools.**
   If you choose the construction point tool you can specify the new light's position. By choosing the construction axis or grid tool you can specify both its position and orientation.
3. **Click in the workspace to place the construction object where you want the new light to be.**
   Rotate the construction object to the orientation you want the new light to assume, if you are using a construction axis or grid.
4. **With the construction object selected, choose Paste from the Edit menu.**
   The new light replaces the construction object.

Duplicating a light object in the workspace

You can also make a new light by duplicating a light in the workspace. Duplicating a light as an object offsets the new light by one unit in the workspace.

To duplicate a light object in the workspace:

1. **Select the light object in the workspace.**
2. **Choose Duplicate from the Edit menu.**
   The new light appears in the workspace, offset one unit from the original.

Customizing and managing lights

Once you have created a light, you can adjust its position and/or orientation in the world and edit its properties to customize it for your scene. You can also create additional lights and customize them to create lighting designs that use multiple lights, such as stage lighting and indoor or outdoor lighting.

Editing light objects

Position and orientation can be adjusted in three ways:

- By adjusting light objects directly in the workspace
- By editing the values of light objects in the Objects browser
- By using the light pointer at the top of the Lights browser (for orientation only)

Editing positions and orientations of light objects in the workspace

Light objects can be moved and positioned in the workspace using any of the tools and techniques you use to move and position any other object.

To adjust the position and orientation of a light object in the workspace:

1 **Choose the arrow tool and select the light object in the workspace.**

2 **Drag the light object to a new position and/or orientation.**
Use the same modifier keys you use for moving and reorienting other objects. However, you cannot scale light objects, and neither ambient lights nor omni lights can be reoriented because they shine in all directions.

Note: To make sure a light object is positioned and oriented exactly as you want it when you are manipulating it in the workspace, try checking it from a number of viewing angles. Use the preset views (front, top, left, and so on) or the four-view setup, or create your own set of custom views.

Tip: Use the watch link tool to watch link a spotlight to the object you want it to illuminate. This ensures that spotlight is oriented correctly relative to that object. You can also link light objects to other objects in your scene or to each other using any of the link tools. Then you can easily position or orient lights as you position and orient the object they illuminate. Or you can move a whole group of lights simultaneously. For more information, see "Linking lights to objects" on page 397.

Editing positions and orientations of light objects in the Objects browser

You can edit the values of light objects in the Objects browser just as you can edit any other Extreme 3D object.

To change the light object's position or orientation by value in the Objects browser:

1. **Select the light object whose values you want to edit.**
   You can do this using the arrow tool and selecting the light object in the workspace. Or you can select the light object by name in the World browser.
2. **Choose Objects from the Window menu to open the Objects browser.**
3. **Place the cursor in the text entry field for the value you want to change.**
   The numbers in the Position fields show, from top to bottom, the x, y, and z coordinates of the object.
4. **Type in a new value and press Enter to apply it to the light object.**

To lock the x, y, or z position or orientation coordinate for a light object:

- Select the check box next to the numeric field whose coordinate you want to lock. When this check box is selected, the corresponding coordinate cannot be changed from the workspace; it can only be changed by editing the value in the position or orientation field. You can still use the Objects browser trackball, but only those coordinates that are unlocked are updated when you release the trackball.

Editing the orientation of light objects in the Lights browser

Using the light pointer at the top of the Lights browser, you can change the orientation of any distant light or spotlight. The narrow end of the light pointer represents the direction the light is pointing. The sphere of the light pointer represents the place in the Extreme 3D world toward which the light is aimed.

To edit the orientation of a light with the light pointer:

1. **Open the Lights browser and select a light in the Lights in Scene list.**
2. **Drag the large end of the light pointer.**
   The numbers in the orientation fields are updated as you move the pointer and reflect the light's new orientation values when you release the mouse. The numbers in the orientation text field are expressed in degrees and are relative to the current view. If you use the light pointer to adjust rotations of an omni light, nothing happens, as omni lights do not have specific orientation values.
3. **Click the Update Scene button to apply the light's orientation change to the workspace.**

Editing the basic properties of lights

Each of the four light types has a set of properties that you can edit to create custom lights for your scene. The properties for lights include:

- A light switch for turning the light off and on
- A color
- An intensity
- Shadow casting
- Light fall off

Change properties of lights in the Light editor, available by clicking the Edit button in the Lights browser.

To edit the properties of a light:

1. **Choose Lights from the Window menu.**
2. **Select the light by name in the Lights in Scene list.**
3. **Click the Edit button below the Lights in Scene list.**
   The Light editor opens.

The following sections describe how each light property can be edited in the Light editor and what effect that property has on the lighting design. For more information about creating specific lighting effects by customizing and combining lights, see "Using multiple lights" on page 361.

Turning lights on and off

When you create a new light from the Lights in Catalog list, the effect of the new light is immediately seen in the workspace. This is because the ***light switch*** for all lights is on by default.

To turn a light off:

1. **On the Lighting page of the Light editor, uncheck the Light Switch check box and click OK.**
   This turns the light off. Turning a light off does not lose its settings, but its settings are not added to the shading calculation when a render is performed.
2. **To see the effect in the scene of turning the light off, click Update Scene.**

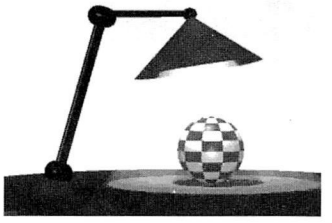
Changing the color of a light

All lights have color. The default color for all lights is white. A number of factors contribute to the overall effect that changing a light's color has on the scene. The light's intensity and its position in the world (for omni and spotlights) plays a part in how much a particular light contributes to the overall light in the scene. Changing a light's color has a greater effect on the scene if the light is a major contributor to the overall lighting scheme.

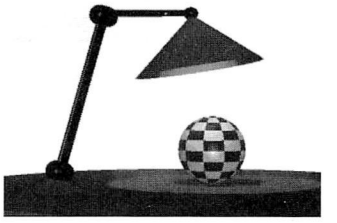
Another factor that contributes to the effect of changing a light's color is the interaction of lights with materials. For example, if every object in your scene has a different custom material each with different specular and roughness settings, every object will respond differently to changing the color of a light.

To change a light's color:

1. **On the Lighting page of the Light editor, click the Color chip.**
   This opens the System Color Picker dialog box.
2. **Select a new color.**
3. **Click OK.**
   The Light editor closes.
4. **To see the effect of the light's new color on the scene, click Update Scene.**



In this picture the light color is white.



In this picture the light color is dark gray.

To see an example of how light colors interact with material colors in an animation:

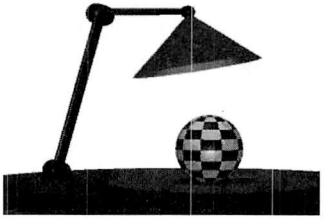
- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Colored Lights" movie.

Editing a light's intensity

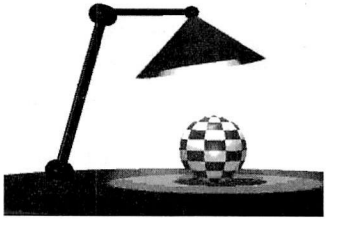
A light's ***intensity*** determines how bright it is. In Extreme 3D you can also decrease the intensity of a light to black. Lights with intensity values between 0 and -20 are called ***negative lights***. A negative light uses the opposite color of its assigned light color, so a negative white light casts black light. One way you can use a negative light is to subtract light from areas of the scene that are too bright. This technique can be used to simulate or enhance shadows.

To change the intensity of a light:

1. **On the Lighting page of the Light editor, enter a value between -20 and +20 in the Intensity field and click OK.**
   The higher the number, the brighter the light. A negative light subtracts light from the scene. Scenes with multiple light values over 1.0 can quickly wash the scene out.
2. **To see the effect of the light's new intensity in the scene, click Update Scene.**



The Colored Lights scene with the intensity very low



The Colored Lights scene with the intensity very high

Note: Use the gamma correction in Final Render Setup to modify the effect that multiple lights with high intensity have on the final rendered image. For more information, see the Reference Section of the Extreme 3D Help system.

To see how a negative light intensity affects the scene in an animation:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Colored Lights" movie.

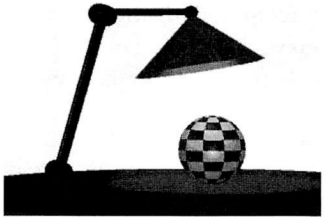
Editing shadows

All distant lights and spotlights have the ability to cast ***shadows***. Many interesting lighting effects can be created, however, by turning shadow casting on only for a select set of lights.

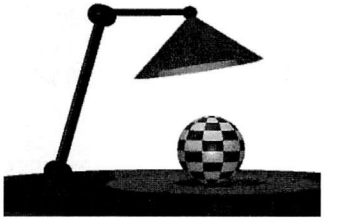
To make a light cast shadows:

1 **On the Shadows page in the Light editor, check the Cast Shadows check box.**

2 **Choose Final Render to Screen to see the shadows you have created.**
None of the interactive renderers render shadows.



In this picture the shadow for the spotlight is off, so there is no shadow under the sphere.



In this picture the shadow for the spotlight is on, so the sphere's shadow is rendered.

Tip: Cast Shadows not only creates shadows, it also prevents the light from passing through objects. Similarly, Cast Dust Shadows both creates dust in shadows and prevents dust from passing through objects. For more information, see "Creating dust and smoke effects with spotlights" on page 359.

A lighting scheme that makes use of shadows only in those areas where they are most effective is not only efficient but often creates a scene with greater visual impact. Enhance your use of shadows by varying their density and crispness according to their focus in the scene. Fine tune these shadow qualities by using the shadow resolution and shadow fuzziness settings.

To set shadow resolution:

- On the Shadows page in the Light editor, enter a number between 32 and 2048. Extreme 3D squares this number to define the resolution of the area that the shadow covers. The area is measured in pixels. A low number creates chunky shadows with obvious pixels. A high number produces smooth, anti-aliased shadows.

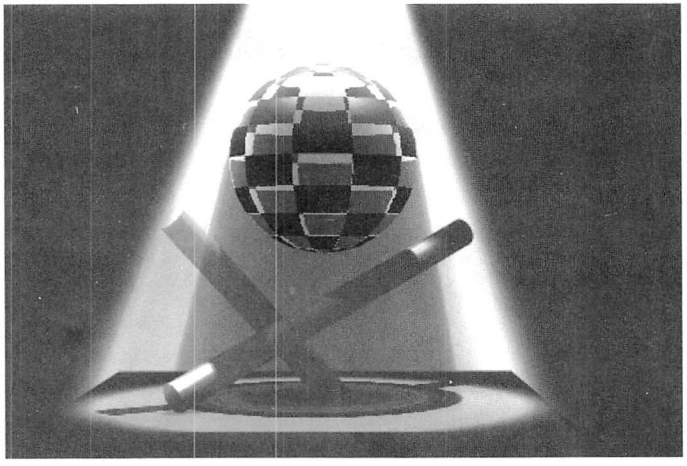
To set shadow fuzziness:

- On the Shadows page in the Light editor, set the Shadow Fuzziness slider to a value between 0 and 20. A high value creates a very soft shadow; a low value produces a shadow with crisper, more defined edges. Large numbers can slow render time considerably. The fuzziness effect depends on the shadow resolution.

You can also decide to have shadows created only for areas of materials that are not transparent. Use a material composed of two different materials with two different transparency values, such as Stripes or Tiles, to create effects like light passing through venetian blinds and casting shadows.

To render a scene with transparency in the shadows:

- Choose Final Render Setup from the Render menu and check the Transparency in Shadows check box. Leave this check box unchecked until you do a final render to speed up test rendering and screen redraws while you design your lights.



Note: Although ambient lights neither cast shadows themselves nor alter the shadows cast by other lights, the presence and color of an ambient light in a scene has an effect on the way the surfaces of objects are shaded. Before finalizing the look of shadows, be sure to check the settings for any ambient lights in your scene so that object shading and shadow density compliment each other.

Each light that casts shadows slows down rendering time and consumes memory. After you have set up the shadows you want, you might want to eliminate shadow calculation from the rendering process in order to do test renders of other lights or materials features. Extreme 3D lets you do this without having to change any of your shadow settings.

To render a scene without shadows:

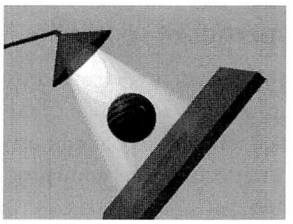
- Choose Final Render Setup from the Render menu and uncheck the Render Shadows check box. Be sure to turn Render Shadows back on when you create the final render of your scene.

Editing a light's fall off

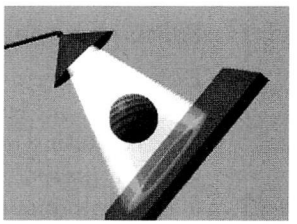
The light fall off property is the distance at which the light is at half intensity. The distance is in units, which you set in the Units dialog box. Only spotlights and omni lights have the fall off property.

To set the light fall off:

1. **In the Light Fall off Distance field of the Light editor, type the number of fall off units required and press Tab.**
   The higher the number, the farther the light shines in the workspace. You can use the working plane or a construction grid to measure the number of units between the light and the place in the scene where you want the light to be at half intensity.
2. **To render the light fall off in the scene, check the Use Light Fall Off check box and click OK.**
   Leave the Use Light Fall Off check box unchecked for quick test renders. The value you assign to light fall off distance is retained, but the fall off isn't calculated for the render. This speeds up rendering time.
3. **To see the effect of the light's new fall off value in the scene, choose Final Render to Screen from the Render menu.**



In this picture the fall off setting for the spotlight is very small.



In this picture the fall off setting for the spotlight is very large.

To see an example of fall off as it is used in an animation:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Light Cone" movie.

Editing the source radius of distant lights or spotlights

The source radius of distant lights and spotlights determine, in part, the size of the highlights these lights cast on objects they shine upon. Because distant lights are infinitely far away, even a small change to the source radius creates a noticeable highlight change. For spotlights, the source radius works in tandem with the cone angle and cone fuzziness values to create visible cones of light and dust.

To change the size of a distant light's source radius:

- On the Lighting page of the Light editor, set the Source Radius slider. For distant lights, the source radius is defined in degrees. The angle is calculated from the center of the light's source and determines the radius of the circle of light the distant light throws. Use a value between 0 and 90.

Tip: Use a small angle like 0.5 to simulate sunlight. Use an angle of 90.0 to create a hemisphere of light on objects the distant light strikes.

To change the size of a spotlight's source radius:

- On the Lighting page of the Light editor, enter a value in the Source Radius text entry field. The source radius of spotlights is set in world units and can be any number greater than 0. This value sets the starting radius of the light. The larger the value, the wider the light is at its source. As a spotlight gets closer to an object, the highlight it creates gets relatively bigger. The spotlight's source radius affects other properties of a spotlight. For more information, see "Customizing a spotlight's cone" below.

Note: The highlight size for all lights is also affected by the roughness and specular values of the materials on those objects.

Editing the special properties of spotlights

Each spotlight casts a cone of light that you can adjust. Use the spotlight's Cone Angle and Cone Fuzziness properties to change the cone's size and crispness of its edge. Create dust or smoke effects with a spotlight using its Dust Cone properties. Combine the spotlight's dust effects and its cone properties to create visible cones of light. This section describes:

- Customizing a spotlight's cone
- Creating dust and smoke effects with spotlights
- Creating a visible cone of light

Customizing a spotlight's cone

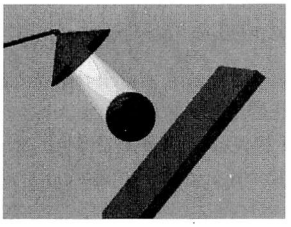
Spotlights can create visible cones of light. You can control the radius of a spotlight's cone, what part of that cone is crisp and clear, and where the edges of the cone become fuzzy.

To change a spotlight's cone:

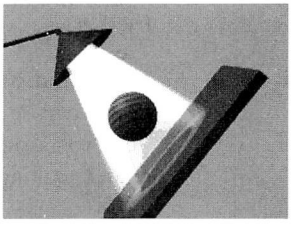
1 **On the Lighting page of the Light editor, set the Cone Angle slider to the angle that you want the spotlight's cone to shine and press Tab.**
The maximum angle is 60 degrees. A slider value of 0 creates a cone angle of 0 degrees. A slider value of 1.0 creates a maximum cone angle of 50 degrees.

2 **Set the Cone Fuzziness slider to the percentage of the cone of light that you want softened or fuzzed.**
A value of 0.5 softens half of the radius of the cone from the outer edge inward. A value of 1.0 softens the whole cone of light.

3 **Set the Source Radius of the light.**
This value sets the starting radius of the light. The larger the value, the wider the light is at its source. The value is in model units. The light cone and the dust cone both take their size from this setting.



In this picture the light cone is small and the fall off is low. The cone is visible because dustiness is on.



In this picture the light cone is large and the dust fall off is high. The cone is visible because dustiness is on.

Tip: To learn how to make the light cone visible, see "Creating dust and smoke effects with spotlights" below.

To see an example of the cone angle as it is used in an animation:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Light Cone" movie.

Creating dust and smoke effects with spotlights

You can create more atmosphere in scenes using spotlights by using their dust properties. Set the dust properties to specify the amount of dust and whether it is evenly distributed or concentrated in smoke-like swirls. Using dust settings also makes the spotlight's cone visible.

To create dustiness or smoke:

1. **Create a spotlight with a cone angle.**
   For more information, see "Customizing a spotlight's cone" on page 358.

2. **On the Dust Cone page of the Light editor, set the relative amounts of dust and empty space using Dust Brightness.**
   This value sets the density of particles that reflect light. For dust to appear and for dust shadows to have an effect, dust brightness must be greater than zero. The dust takes on the color and intensity of the light. As dust brightness increases, the intensity of the light and the scattering of the dust particles increases. Keep dust brightness rather low in most cases. Too much dust can overwhelm the scene.

3. **Type the desired number of fall off units in the Dust Fall Off Distance field.**
   Use a smaller number for dust fall off distance if you want dust to appear mostly around the light source. Match the light fall off distance and the dust fall off distance if you want dust to fill the whole cone of light.

4. **To render dust fall off in the scene, check the Use Dust Fall Off check box.**
   Leave the Use Dust Fall Off check box unchecked for quick test renders. The value you assign fall off is retained, but the fall off isn't calculated for the render, making the rendering process quicker.

5. **Set the Turbulence Contrast to a value between 0 and 1.0.**
   The turbulence contrast and the dust turbulence sliders work together to specify the character of the dust, creating even dust throughout the cone of light, swirls of dust, or smoke in concentrated areas. Use a Turbulence Contrast value of 0 to achieve a smooth dust cone. Higher offset values fill the dust with swirling or cloudy patterns of dust.

6. **Set the Dust Turbulence slider to a value between 0 and 1.0 to determine how evenly the dust is distributed throughout the cone of light.**
   Use this slider in combination with the Turbulence Contrast value. Dust Turbulence modifies further the swirling or cloudy patterns that a higher Turbulence Contrast value creates. With a lower Dust Turbulence value, the particles are evenly dispersed and create dusty sunbeam-like effects. With a higher Dust Turbulence value, the particles clump together, creating uneven and smoky effects.

7. **Set the Turbulence Scale to determine how much space the concentrated swirls of dust fill.**
   The size of swirls is in world units as determined by your settings in the Units dialog box in the Object menu. With a high number it is possible to make dust clouds or smoke clouds, depending on your Dust Turbulence value.

8 **If you want shadows cast in the dust as well as on objects, select the Shadows page and check Cast Dust Shadows.**
When this check box is checked, shadows are rendered in the dust itself and rendering time is increased. This has the effect of keeping the cone of light from passing through objects. Depending on the rendering style you are using and whether you are using interactive or final rendering, checking Cast Dust Shadows may make dust specks visible. These specks are reduced when you choose a higher rendering quality.

9 **Choose the enhancement you want, if any, from the Dust Shadow Enhancement pop-up.**

- **Enhance Dust Shadows**—Creates more defined and visible dust shadows.
- **Enhance Light Rays**—Enhances the shafts of light generated by a spotlight with dust; this is an especially good option for making sure light passes through small holes or transparencies in the object's surface.
- **Enhance Both**—Both kinds of enhancements are used.
- **No Enhancements**—No enhancements are used.

Note: When you are ready to perform a final render of a scene that uses dust, check the Render Dust Cones check box. Leaving this box unchecked as you continue to design lighting speeds up rendering time while retaining all dust-related settings.

To see an example of the dust cone and dust fall off as it is used in an animation:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch "Light Cone" movie.

To see an example of dust brightness, dust turbulence, and dust shadows as they are used in an animation:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Shadows and Dust" movie.

Using multiple lights

As you add more lights to the scene, you might need to change the lights' properties to balance their interaction with each other and your materials, and keep the scene from becoming too washed out. You can also achieve a number of special lighting effects by artfully combining, positioning, and editing the values of multiple lights.

Because Extreme 3D does not render light objects, you can put lights in your scene anywhere you want. This can be especially useful for adding local accents once you have created your general lighting design. A single spotlight at a low intensity placed very close to an object may give you the kind of highlight that the material's specular value alone doesn't provide. A distant light directed at the scene's horizon level can create the effect of reflected light in a scene. Experiment with the placement, orientation, and values of multiple lights to create many lighting designs and effects.

- By positioning spotlights at the ground level of your scene as footlights and in rows above your scene as stage lighting instruments, you can simulate a stage lighting look. You can assign the lights colors to create the effect of using gels. Watch link a spotlight to your main character for a follow spot. For more information, see "Animating lights and materials" on page 396.
- To create an outdoor daylight look, set the ambient light color to a light blue. Use two distant lights for your main lighting. Set the color of one to white and set its source radius to a small value, such as 0.5 and turn its shadows on. Set the color of the other one to light blue, set its source radius to 90 and turn its shadows off. Use omni lights for accent lights where you want strong highlights on objects. You can enhance this effect with your material's values. For more information, see "The interaction of lights and materials" on page 328.

Managing lights

Extreme 3D has several features that help you manage multiple lights. Although multiple lights create more rendering overhead, by using one of several organizational strategies, you can optimize test renders to minimize this overhead as you create your lighting design. If you name and organize your lights in the Lights browser, your organizational strategy is easier to maintain and working with multiple lights is less confusing. This section describes the organizational strategies of:

- Renaming lights in the Lights browser
- Deleting unused lights from the Lights browser
- Using layers to organize lights in a scene
- Using light property toggles to optimize testing
- Copying lights from other scenes
- Cataloging lights and saving them as light files

Renaming lights in the Lights browser

If you give your lights names that are descriptive, it is easier to remember how they function in the scene. This also makes it easier to share lights across scenes.

To rename lights in the Lights browser:

1. **Decide on a naming strategy for lights, alphabetical or numerical, for example.**
2. **Choose Lights from the Window menu to open the Lights browser.**
3. **From the Lights in Scene list, select the light you want to rename.**
   When a light is selected, its name appears in the text field below the Lights in Scene list.
4. **Type a new name in the text field and press Enter.**
   The light is renamed.

Deleting unused lights from the Lights browser

Your organizational strategy is easier to maintain (and working in the Lights browser is faster) if you delete those lights that you are no longer using.

To delete a light from the scene:

1. **Choose Lights from the Window menu to open the Lights browser.**
2. **From the Lights in Scene list, select the name of the light you want to delete.**
3. **Press the Delete key or choose Cut from the Edit menu.**

Note: Lights that are represented as objects in the workspace can be deleted from the scene by selecting the light object in the workspace and choosing Cut from the Edit menu.

Using layers to organize lights in a scene

For lights that are represented as objects in the workspace, you can use layers to speed up your test rendering process. By creating a layer for a specific set of lights and then hiding that layer, you can test the effect of that set of lights on the scene. This technique can also be used to speed up test renders. For more information about using layers, see the Reference section of the Extreme 3D Help system.

Using lights property toggles to optimize testing

You can use the light switch, shadow toggle, and fall off toggles to speed up testing. Lights that don't affect a certain area can be toggled off when you do test renders. Shadows and fall off can be toggled off when you aren't testing those features. All shadows can be shut off using the Final Render Setup dialog box. Be sure to toggle them back on before performing your final renders.

Copying lights from other scenes

There are two ways you can save lights that you have created for use in other scenes. You can copy lights from one file into another using the Lights browser, or you can save lights to a catalog. Sharing lights across scenes by copying them is best for single lights.

To copy lights from one scene to another using the Lights browser:

1. **Open the scene file that contains the light you want to copy.**
2. **Choose Lights from the Window menu to open the Lights browser.**
3. **From the Lights in Scene list, select the name of the light you want to copy and choose Copy from the Edit menu.**
4. **Open the scene file you want to copy the light into.**
   The Lights browser updates to display the lights that are in the newly opened scene.
5. **Click the Lights in Scene list, then choose Paste from the Edit menu.**
   The light name appears in the Lights in Scene list and the light object (for omni and spotlights) appears in the workspace in the position and orientation it had in the scene from which it was copied.

Cataloging lights

Saving lights to the catalog is especially useful when you want to use the same set of lights for several scenes.

To save any customized lights for use in other scenes:

1. **Select the light you want to save in the Lights in Scene list.**
2. **Click the right double-arrow button.**
   This moves the light into the Lights in Catalog group and they appear in the Lights in Catalog list the next time you start Extreme 3D. Cataloged lights are saved in the current catalog as LIT files. By default, this catalog is stored in the Material folder inside the Scripts folder.

To remove a light from a catalog:

1. **Find the folder that contains your lights catalog.**
   For the default lights catalog, find the folder that contains your Extreme 3D application. Within this folder locate the Scripts folder, and the Material folder inside that.
2. **Delete the light (LIT file) that you no longer want.**

Customizing and managing materials

The process you use to customize materials is similar in some respects to lights. Just as you customize lights by starting with Extreme 3D's set of default lights, you can customize materials by starting with Extreme 3D's set of default materials.

As you work with materials, you'll want to check how different lights affect the materials you use, then adjust the properties of both until you achieve the effect you want. One way to do this is to perform test renders as you work with materials. This way you can see if the values you choose for materials are giving you the effect you want with the lights you are using.

The following sections discuss how to apply and customize materials, how to use and apply texture maps, and how to manage materials and maps. All material properties are described fully in the Extreme 3D Help system. Also, for more information about how materials are affected by lights, see "The interaction of lights and materials" on page 328.

Applying materials

When you first open Extreme 3D, there is one material in the Materials in Scene list. It is called Gray Plastic and is a variation of Generic+Texture. This material is assigned to all new objects by default. As you create the materials you want for your scene, you can replace the default material by applying your new materials to the objects in your scene. This section describes:

- Applying materials using the Materials browser
- Using the paint bucket tool to apply materials

Applying materials using the Materials browser

As you create customized materials, you can use the Materials browser to immediately apply your materials to objects in your scene.

To apply a material from the Material browser:

1 **In the workspace, select the objects to which you want to apply a material.**

2 **Choose Materials from the Window menu to open the Materials browser.**

3 **Then, either:**

- Click the name of a material in the Materials in Scene list.
- Or double-click the name of a default material in the Materials in Catalog list.

The default material appears in the Materials in Scene list. You can either use the default material as is or edit it to create a new material. For more information, see "Customizing materials" on page 367.

4 **Click the Apply button. Press the F2 key (Windows) or the Control key (Macintosh) to apply a material to an object and all of its children.**
Extreme 3D applies the selected material's attributes to the selected objects, redrawing the model to display the new material attributes.

Use the texture map placement and material orientation tools to position and orient materials on an object after you apply them. Solid materials can be projected through the object or on the surface of objects, like texture maps. Choose any of the five mapping types in the Objects browser. You can also use one of the texture placement tools to determine a mapping type, or to scale or offset a texture map or solid material pattern. For more information, see "Choosing a mapping type and placing texture maps on objects" on page 378.

Using the paint bucket tool to apply materials

You can also apply materials using the bucket and eyedropper tools. These tools work in the same way as the paint bucket and eyedropper tools in paint and draw applications. Applying materials with the paint bucket tool is especially useful once you have customized materials for your scene and are adding those customized materials to new objects.

To apply a material with the bucket tool:

1 **Select a material in one of two ways:**

- Choose Materials from the Window menu to open the Materials browser. Then click the name of a material in the Materials in Scene list.
- Or choose the eyedropper tool, by clicking and dragging the bucket tool in the tool palette. Then click the object that displays the material you want to pick up.

2 **Choose the paint bucket tool from the tool palette.**

3 **Click the object to which you want to apply the current material. Press F2 (Windows) or Control (Macintosh) while clicking the parent object to apply a material to an object and all of its children.**
Extreme 3D applies the current material's attributes to the object, redrawing the scene to display the new material attributes.

Customizing materials

By starting with any of Extreme 3D's eight default material types and editing the material's property values, you can create a vast variety of materials for your scene. In order to create exactly the look you want for your scene, you might want to establish your lighting design first and then customize your materials to finish the look. Or, you might want to take an iterative approach by experimenting with a lighting design, trying out some materials, and then going back to tweak the lights and materials values. Whichever approach you choose, you'll find that it's easy to experiment with various options and do test renders to check the results.

All materials have several basic properties. By changing the values of these properties in the Material editor you can customize materials to create the surface effects you want. This section describes:

- Opening the Material editor
- Defining the surface color of a material
- Changing the brightness of a material
- Changing a material's highlight size and color
- Making a material transparent or opaque

Opening the Material editor

All materials properties are edited using the Material editor. Each of the eight material types uses it unique set of pages in the editor. When you choose a material to edit, the editor displays the pages you need to define the properties for the material that is selected.

To edit the properties of a material:

1. **Choose Materials from the Window menu to open the Materials browser.**
2. **Select a material in the Materials in Scene list.**
   A material called Gray Plastic always appears in the Materials in Scene list. Gray Plastic is an instance of Generic+Texture and has all the basic material properties. It is a good material for beginning experimentation. You can change its name and all of its properties but you can't delete it from the scene.
3. **Click the Edit button below the Materials in Scene list.**
   The Material editor opens. You can change the surface color, specular, roughness, luminosity, and transparency colors of the material to create a new material. For more information about these properties and their effects, see the Extreme 3D Help system.

Defining the surface color of a material

The ***surface color*** of an object simulates the color we see in the real world when light is first absorbed into an object and is then reflected outwards. This action of absorbing light in and then reflecting it back out is the reason grass looks green. This is called the diffuse component of reflection. In Extreme 3D it is called the surface color and is the principal color of the material. Many of the solid materials use two or more surface colors combined in patterns.

To change the surface color of a material:

- Click the color chip labeled Color in the Material editor to open the System Color Picker dialog box, choose a color, and click OK. Ambient light is reflected according to the surface color. It controls the apparent contrast of the surface color in areas that are shaded or facing away from a light source.

Changing the brightness of a material

How bright or dim a material appears in the absence of light is determined by its luminosity. Edit the luminosity color of a material to create special effects such as glowing light bulbs or hot metal. Luminosity can also be used to simulate the effect of ambient light on an individual material.

To set the luminosity of a material:

- Click the Luminosity color chip in the Material editor to open the System Color Picker dialog box, choose a luminosity color, and click OK. A luminosity color several shades lighter than the surface color produces a glowing effect. Colors significantly lighter than the surface color can overpower the surface color and wash the object out. Luminosity color appears to brighten the effect of the ambient light.

Changing a material's highlight size and color

A specular highlight is the direct reflection of the light source off of the object. The size, intensity, and color of the specular highlight is controlled by the material's specular and roughness colors.

To set the specular or roughness color of a material:

- Click the Specular or Roughness color chip in the Material editor to open the System Color Picker dialog box and pick a color.

If the specular color is a shade of gray, the specular highlight is the same color as the light. When the specular color is close to white, the surface reflects all the light hitting it and takes on the color and intensity of the light. When the specular color is anything but white, it scales the color of the light. This can be used for creating special surfaces like Christmas ornaments.

The roughness color controls the size of the highlight. The darker the roughness color, the smoother the surface and the smaller the highlight. A roughness color other than black, white or gray creates a different size highlight for each component (RGB) of the light source. Use this to create colored halos around highlights, as for metallic effects.

To see an animation that demonstrates how specular and roughness values define a material's shininess:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Specular and Roughness" movie.

Making a material transparent or opaque

The transparency color determines how solid a surface appears to be. Transparency controls the degree to which other objects and light behind an object show through it. The transparency color sets the alpha channel value of any final rendered image.

To set the transparency factor of a material:

- Click the Transparency color chip in the Material editor to open the System Color Picker dialog box and pick a color. If the transparency color is black, the surface has a completely solid appearance, like metal. A white transparency produces a transparent surface like very thin plastic. Objects with lighter transparency values can sometimes looked washed out. You can counteract this effect by using darker surface and specular colors for these objects.

To see an animation that demonstrates animating a material's transparency:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Transparency" movie.

Materials that have transparency are transparent not only to objects behind them but to light as well. This means that those parts of the material that are transparent don't cast shadows. This is especially useful for creating effects with texture maps, such as shadows cast by leaves, or effects with solid materials, such as shadows cast by clouds. To see these effects rendered, make sure rendering of transparent shadows is on in Final Render Setup.

To turn transparency shadows on:

- Choose Final Render Setup from the Render menu and check the Transparency in Shadows check box. Calculating shadows for transparency can be time consuming. If you don't plan to use any transparency shadow effects, or if you have created and tested your transparency shadow effects and want to speed up test rendering of other features, turn off the rendering of transparent shadows.

Note: Transparency effects appear in final renders of the image.

Creating several standard materials from the default materials

Each of the default material types has additional properties that are unique to their type. You can use some of these properties to define surface patterns, and others to specify how you want multiple surface colors to be blended. This section describes:

- Previewing the default material types
- Creating clouds from Organic Magic
- Creating glass from Generic+Texture
- Creating wood from Stripes
- Creating different materials from one default material

Previewing the default material types

Use the Materials browser to preview the eight default materials. This might help you choose the one that offers you the property set you need for the look you want.

To preview the eight default material types:

1. **Choose Materials from the Window menu to open the Materials browser.**
2. **Double-click the name of one of the default materials in the Materials in Catalog list.**
   The object in the Preview window updates to display the material. A copy of the default material appears in the Materials in Scene list.
3. **Select a material by name from the Materials in Scene list and click the Edit button to see the set of properties that define the material.**

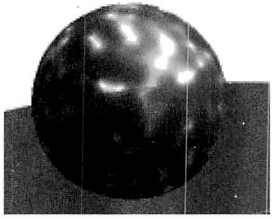
Once you have familiarized yourself with the properties of the basic material types, you might want to look at the preset materials installed with Extreme 3D. This set of over 200 materials is made from the eight default material types. For more information, see "Using the preset materials" on page 394. Also try experimenting with making a few standard materials that you need for most scenes. The following sections present several suggestions to get you started.

Creating clouds from Organic Magic

Each of the default material types is best suited to certain categories of materials. Organic Magic, for example, is especially useful for creating clouds and other natural materials.

To create clouds using Organic Magic:

1. **In the Materials browser, move a copy of Organic Magic from the Materials in Catalog list to the Materials in Scene list by double-clicking the name.**
   The new material becomes the selected material in the Materials in Scene list.
2. **Click the Edit button to edit the material's properties.**
3. **Set the first material surface Color to white. Set the Specular color to white and the Roughness color to dark gray. Set the Transparency color to black.**
4. **Set the second material's surface Color to black and the Specular color to black. Set the Luminosity color to black. Set Transparency to white.**
5. **Set Material Proportions to a low value (0.3).**
6. **On the Pattern page, experiment with the Pattern Transition (Smooth), Pattern Complexity (Medium), and Pattern Scale until the effect is right for the object you are applying the material to.**



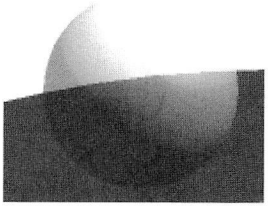
This sphere has a cloud material applied to it that was made from Organic Magic.

Creating glass from Generic+Texture

It pays to experiment with the default material types when you are customizing materials for your scene. For example, although Chrome+Glass is designed to create refractive looks like glass, you can achieve the effect of a thin glass shell using Generic+Texture.

To create glass using Generic+Texture:

1. **In the Materials browser, double-click Generic+Texture to move a copy of Generic+Texture from the Materials in Catalog list to the Materials in Scene list.**
   The new material becomes the current material in the Materials in Scene list.
2. **Click the Edit button to edit the material's properties.**
3. **Set the surface Color to a shade of light blue.**
4. **Set the Specular color to a blue that is almost white. Set the Roughness color to a gray or dark blue. Set the transparency color to white.**
   You won't see an object's transparency unless there is another object behind it.
5. **Set the luminosity color to a dark blue or gray**



This sphere has a glass material applied to it that was made from Generic+Texture.

Note: For a more complex glass material that makes use of an environment map, you can use the same specular, roughness, and transparency values as in step 4 with the glass effect in Chrome+Glass.

Creating wood from Stripes

Many of the materials that you can create from a given default material type might not seem obvious at first. For example, Stripes is clearly suited to making stripe patterns, but you can also use it to create wood looks by adding warp to the patterns. Experiment with the pattern options and surface colors in Stripes to create a variety of materials.

To create wood using Stripes:

1 **In the Materials browser, move a copy of Stripes from the Materials in Catalog list to the Materials in Scene list.**
The new material becomes the selected material in the Materials in Scene list.

2 **Click the Edit button to edit the material's properties.**

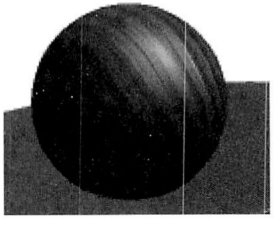
3 **Set one material surface Color to a light brown. Set its Transparency color to black and its Luminosity color to a dark shade of the surface color. Set its Specular color to a dark red-gray and its Roughness color to a dark gray.**

4 **Set the other material surface Color to a dark brown. Set its Transparency to a light gray and its Luminosity to a dark color. Set Specular to dark brown and Roughness to gray.**

5 **On the Pattern page, start with the planar Pattern Type and a Pattern Scale of 0.1.**

6 **On the Warp page, start with a low Turbulence value (0.3).**

7 **Experiment with these settings and with Materials Proportions (0.8), Edge Sharpness (0.2), Turbulence Scale (0.1), and Bump Height until you get the wood effect you want.**



This sphere has a wood material applied to it that was made from Stripes.

Creating different materials from one default material

The default materials are not limited to making one specific type of material. For example, you can use Scratched Metal to make fabric-like materials by using the checked pattern at a small pattern scale. If you assign two shades of brown to Organic Magic and match the specular colors to their respective surface colors, you can create an earth-like material. Add bumps and reduce the scale and you have sand. Experimentation often leads to surprising and satisfying results.

A large number of preset materials created from the eight default material types is available on the application CD. For more information about bringing them into the Materials browser for your scene, see "Using the preset materials" on page 394. They can provide you with instant materials as well as inspiring some new material creations of your own.

Using texture maps

Another way you can give surface qualities to objects is to use ***texture maps***. Texture maps are bitmapped graphics that are wrapped around objects to give their surfaces texture and color. In Extreme 3D, there are two default material types that use texture maps: Generic+Texture and Mondo Map.

You can use Generic+Texture to give fast-rendering surface qualities and color to an object by wrapping a single texture map around it in much the same way as you wrap a gift. By using Mondo Map, you can use a different texture map for each attribute of the surface, such as transparency or specularity. Texture maps that create a bumpy texture are called ***bump maps***. Those used to create shininess and highlight information are called ***specular maps*** and ***roughness maps***. Brighten or darken shaded areas of a material and create glowing effects with ***luminosity maps***.

Bitmapped graphics can also be used as environment maps. You can use either Mondo Map or Chrome+Glass to create reflective materials and then use an environment map to reflect in those materials.

Be sure to rename your texture maps so that you can identify the purpose for which you made them. For example, the names MapSpec, MapBump, MapEnv can be used to distinguish between maps you create for use as specular maps, bump maps, or environment maps.

There are several steps to using texture maps and a number of different effects that you can achieve using them. This section describes:

- Creating texture maps
- Assigning a texture map to an object
- Choosing a mapping type and placing texture maps on objects
- Orienting texture maps to objects
- Tiling and flipping texture maps
- Using environment maps
- Using multiple maps
- Creating effects with the alpha channel
- Using mapping features with solid materials

Creating texture maps

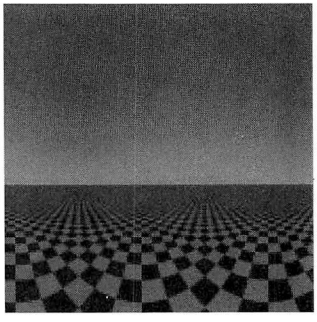
A large selection of texture maps can be found in the Wraptures folder on the application CD. You can also create your own texture maps using a texture creation or graphics application.

If you make your own texture maps, you need to design your graphics according to how you plan to use them. If you plan to use any of the alpha channel effects that the Texture Map default material and Mondo Map default material provide for, save the bitmapped graphics you create as 32-bit images so the pixels have an ***alpha channel.*** The alpha channel of a pixel determines how transparent it is. Images that are less than 32-bits carry only red, green, and blue information for each pixel; they do not carry transparency information. In a 32-bit image, an alpha value of 1 is completely opaque, values between 0 and 1 are levels of transparency, and a value of 0 is completely transparent. The image that you use for a texture map must have some alpha information, that is, the alpha channel must have a value other than 0 or 1.0 if you want the alpha options in the texture map editor to have an effect. Set the alpha channel in the graphics application you use to make your maps. For more information, see "Creating effects with the alpha channel" on page 389.

If the object you plan to wrap a map around is spherical or if you want to use it as an environment map, design your graphic as a ***Mercator map.*** Then the map wraps around the object in a more predictable way when you use spherical mapping and appears properly distorted if you use it as an environment map.

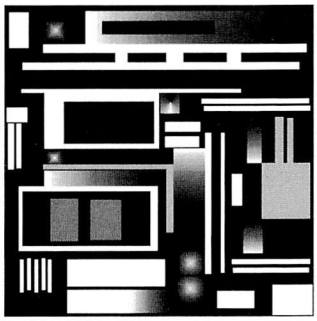
Environment maps, because they are providing background information, work best if they mimic the scene in which you are using them. For example, if there is a horizon in your scene, create an environment map that has a horizon and is lighter above the horizon and darker below it. Distorting the foreground and blurring the image can also help enhance the effect of an environment map.

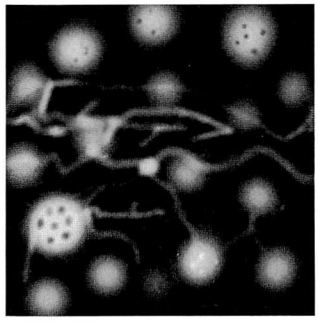
A texture map



An environment map

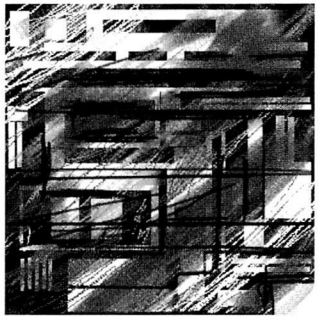
Create gray scale images to use as bump maps. Extreme 3D interprets changes from one shade of gray to another as peaks or valleys to create a bumpy texture.





Two examples of bump maps

Great specular maps can be made simply by creating single color cross-hatch patterns in a paint program or by creating an overall pattern using a noise filter in an image manipulation program. Build complex textures using Mondo Map by making several copies of a single map, altering each copy slightly to achieve bumpiness, specularity, or luminosity effects, and then associating each map with its related property in the Material editor.



This specular map is made from the same graphic as one of the previous bump maps. Scratch patterns were added to a copy of the bump map image to simulate specular effects.

Tip: In order to scale texture maps rapidly, Extreme 3D makes several copies of the bitmapped image when it converts it for use as a texture map. If it is important for the effect you are creating that images aren't stretched in this scaling process, create them at sizes that are square powers of two. The sizes 256 x 256, 512 x 512, or 1024 x 1024 are the unscaled resolutions of commonly used maps.

Note: The maximum resolution for texture maps is 1024 x 1024.

Assigning a texture map to an object

Once you have the texture map you want, there are three steps to applying it to the object: assigning one of the texture map materials to the object, choosing a mapping type for placing the map, and placing and orienting the map on the object in the workspace. One map can be mapped a variety of different ways and on different objects.

Generic+Texture is the easiest of the three texture map materials to use. Because it uses a single texture map that is directly applied to the object, it is the best texture material type to start experimenting with. Once you've applied a single texture map in Extreme 3D, the process for using multiple maps to create more complex textures is easier to understand.

To apply a single texture map to an object:

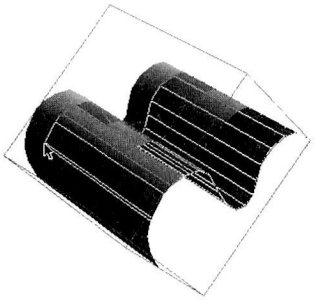
1. **Choose Materials from the Window menu to open the Materials browser.**
2. **Double-click Generic+Texture in the Materials in Catalog list.**
   This moves an instance of this material to the Materials in Scene list.
3. **Click the Edit button to open the Material editor and choose the Texture page.**
4. **Click the image map thumbnail to open the standard directory dialog box.**
5. **Choose any 2D image file to use as the texture map.**
   The image is converted to a TEX file and a new instance of Generic+Texture appears in the Materials in Scene list. The map is assigned to any currently selected objects. For more information about the properties of various image files, see the Extreme 3D Help system.

Note: Extreme 3D makes sure TEX files themselves have names that are cross-platform compatible and as close to the name of the image from which the texture map was created as possible. By default, Extreme 3D saves TEX files in a folder called Material inside the Scripts folder in the same location as the Extreme 3D application. Use the Collect option on the File menu to move texture files with the scene file. For more information, see the Reference section of the Extreme 3D Help system.

Choosing a mapping type and placing texture maps on objects

By default, texture map materials use the intrinsic mapping type. Once you have assigned a texture map material to an object, however, you can change its mapping type. An object's mapping type determines how the texture map is wrapped around it. There are six mapping types.

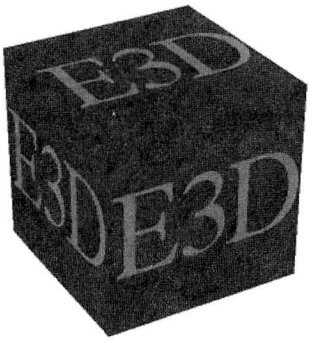
With ***intrinsic mapping,*** the four corners of the two-dimensional texture map are matched to the geometry coordinates of the object to which the map is being applied. The map follows the natural coordinates of the object's surface. This is the default mapping type for all objects except metaforms.



Intrinsic mapping type

Note: To use intrinsic mapping on objects with end caps, separate the end caps and map them separately.

With ***cubic mapping,*** the map is replicated six times so that each face of a cube is covered by it.

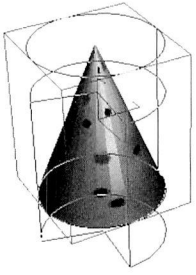


Cubic mapping type

The ***spherical mapping*** type wraps the map like a cylinder around a sphere and then pinches the top and bottom of the image into poles, reducing the top and bottom into one point. This is called a mercator projection. When the mapping is completed, it looks as if the image is shrink-wrapped onto the object.

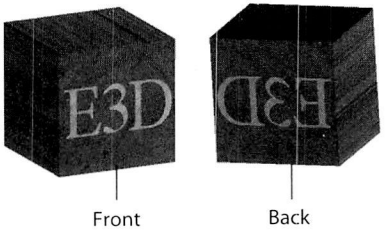
Spherical mapping type

The ***cylindrical mapping*** type wraps a 2D texture map into a cylindrical shape and then applies it onto the object. This mapping type is especially good for putting labels on cylindrical containers.



Cylindrical mapping type

With ***projective mapping,*** the map is projected orthographically all the way through the object's volume.



Projective mapping type

New objects are created with a default mapping type. For all objects except metaforms, the default mapping type is intrinsic. Because metaform objects have no instrinsic mapping coordinates, they are created with projective mapping type as their default. Applying a solid material, such as Marble, to an object changes the object's default mapping type to projective. You can, however, use solid materials to create surface materials rather than solid materials. For more information, see "Using mapping features with solid materials" on page 390.

Note: Certain kinds of objects benefit from a specific mapping type. For example, if you animate an object's deformations, the intrinsic mapping type makes the material look deformed as well. Other mapping types don't follow the deformations.

You can assign a mapping type to an object in the Objects browser, or you can set its mapping type by choosing a particular texture placement tool.

To assign an object a mapping type in the Objects browser:

1. **Select the object in the workspace.**
2. **Use the Materials browser to apply a texture map material to the object.**
   Multiple objects can be selected and assigned a texture map. For more information, see "Applying materials" on page 365.
3. **Choose Objects from the Window menu to open the Objects browser.**
4. **Choose the mapping type that you want.**
5. **Choose the corresponding texture map placement tool and position the map on the object interactively in the workspace, described in the following procedure.**

To assign an object a mapping type using the texture placement tools:

1. **Assign a texture map material to the object in the Materials browser.**
   For more information, see "Applying materials" on page 365.
2. **Choose the texture placement tool that wraps the map around the object in the way you want.**
   For cubic mapping, place the map using the intrinsic texture placement tool, then reset the mapping type to cubic in the Objects browser.
3. **Use the modifier keys to apply the map.**
   You can change the guides of the projective placement interactively to fit a texture map precisely to any object.
4. **When you're finished specifying the location of the texture map, press Enter or click in the workspace to complete the placement.**
   The mapping type is saved with the object and appears in the Objects browser.

For more about the texture map placement tools, see the Reference section of the Extreme 3D Help system.

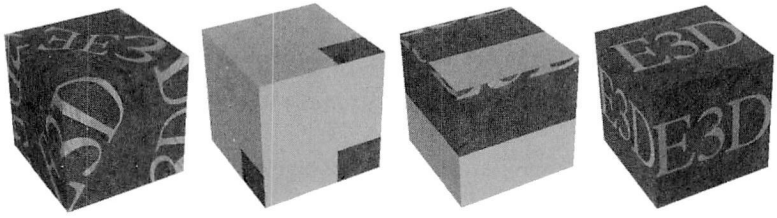
Orienting texture maps to objects

Once you have created a texture map, assigned it to an object, defined its mapping type, and placed it on the object, you can use the material orientation tool to orient the map in any direction along the object.

To orient a texture map or material to an object:

1 **Choose the material orientation tool from the tool palette.**

2 **Use the F3 and F4 keys (Windows) or the Option and Command keys (Macintosh) to move the material along the surface of the object until it is oriented the way you want it.**
You must first apply the material to the object. For more information, see "Applying materials using the Materials browser" on page 365.



Using the material orientation tool, you can orient a map on an object in a number of ways.

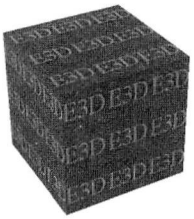
Note: You can also use the material orientation tool to orient the solid materials, such as those made from the Marble, Stripes, or Tiles materials. For more information, see "Using mapping features with solid materials" on page 390.

Tiling and flipping texture maps

You can tile and flip texture maps by using these options in the Objects browser. *Tiling* replicates the texture map across the surface of the object.

To tile a texture map:

1. **Follow the steps described earlier for creating and assigning a texture map.**
2. **Choose the texture placement tool that wraps the map around the object in the way you want and place the map.**
   You determine the number of times the map is replicated by placing and scaling the map so that it defines the area of one tile.
3. **With the object still selected, choose Objects from the Window menu to open the Objects browser.**
4. **On the Info page, check the Tile check box.**
   The texture map is tiled across the surface of the object.



A texture map tiled on a cube

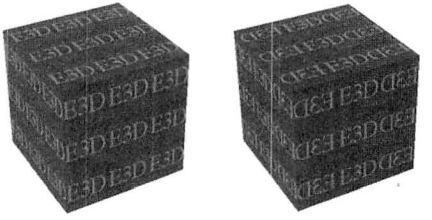
Flipping mirrors the texture map across either the x-axis or the y-axis of the object. Flipping works whether or not tiling is on, so you can also use flipping to correct a map that looks backwards.

To flip a texture map:

1 **Follow the steps described earlier for creating, assigning, and placing a texture map.**

2 **With the object still selected, choose Objects from the Window menu to open the Objects browser.**

3 **On the Info page, check the Texture X Flip or Texture Y Flip check box, depending on which axis you want the texture to flip around.**
The texture map, or neighboring tile textures if the surface is tiled, flip around the specified axis of the object.



A tiled texture map before and after flipping

Tip: By flipping both x and y, the map tiles in a seamless fashion.

Note: The mapping type affects the results of tiling and flipping. For more information, see "Using mapping features with solid materials" on page 390.

Using environment maps

Environment maps are used by the two default materials types that can create reflective materials, Mondo Map and Chrome+Glass.

To create a reflective material that uses an environment map:

1 **Choose Materials from the Window menu to open the Materials browser.**

2 **In the Materials in Catalog list, double-click Chrome+Glass.**

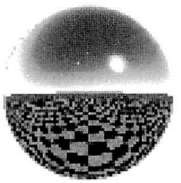
3 **Click the Edit button to open the Material editor.**

4 **Choose the Surface page and click the map image to choose the image you want to use for an environment map.**
This opens a standard directory dialog box.

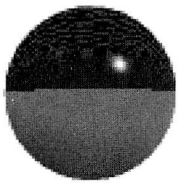
5 **Choose any 2D image file to use as the environment map.**
The image is converted to a TEX file and becomes the environment map that is reflected in the material you are creating. For more information about the properties of various image files, see the Extreme 3D Help system. For best results, use a spherical or mercator projection when creating the image to use as an environment map.

6 **Create the kind of reflective surface you want by experimenting with the options.**

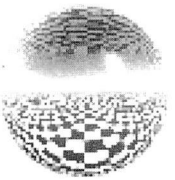
- When you select Chrome as the Environment Mapping Effect option, the map is reflected. Most of the environment map detail is visible on the object's surface. Any settings that appear on the Glass page of the Material editor are ignored.



- When you select Glass as the Environment Mapping Effect option, the map is refracted through the object. The material gets its color from the environment map modified by the Glass color. Curved surfaces act like a lens and can invert the environment map. Any settings that appear on the Chrome page of the Material editor are ignored.



- When you select Chrome and Glass as the Environment Mapping Effect option, the environment map is both reflected and refracted. All the settings for both pages are used. This setting produces the most realistic-looking glass, as real glass reflects some light and refracts the rest.



Note: Environment maps are fixed to the world coordinate system, so reflections and refractions move correctly as you move the camera.

To see an animation that demonstrates several uses of an environment map on Chrome+Glass:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Chrome+Glass" movie.

Using multiple maps

Using Mondo Map, you can set the standard material properties of surface color, specular, roughness, transparency, and luminosity colors either by assigning each a specific color or by assigning each an individual texture maps. You can also incorporate a bump map and an environment map. In this way you can create richly detailed surfaces using multiple textures.

To apply multiple texture maps to an object:

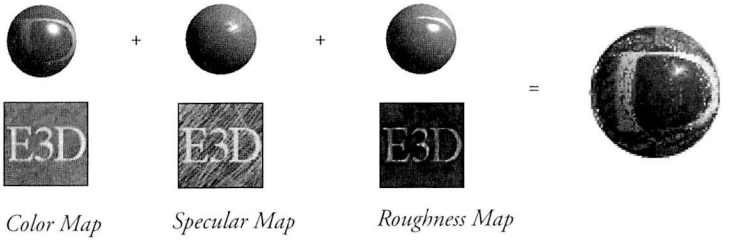
1. **Choose Materials from the Window menu to open the Materials browser.**
2. **In the Materials in Catalog list, double-click Mondo Map.**
3. **Click the Edit button to open the Material editor.**
4. **Click the page for the property you want to map and then click the map image to choose a texture map for that property.**
   This opens a standard directory dialog box.
5. **Choose any 2D image file to use as the texture map.**
   The image is converted to a TEX file and becomes the map that is used for the material property you are editing. For more information about the properties of various image files, see the Extreme 3D Help system.
6. **Repeat steps 4 and 5 for other properties you want to map.**
   Check the Use Map check box on every property page for which you want a map to be used. For those properties that you do not map, the color for that property is used instead. This color is also used outside the area covered by the map.

7 **Fine-tune the look of the surface by experimentation.**
Use the Intensity slider on each of the property pages to control the intensity of each map relative to the other maps you are using. The effect that each property's color and map has on the surface is described below.

- A surface color determines the main color of the material. This color is affected by the color of lights. You can create several effects with the color map by choosing one of the Alpha Use options. For more information, see "Creating effects with the alpha channel" on page 389.

- When the specular color is black, there are no reflections. When the specular color is white, the surface reflects all light hitting it. Using a specular map gives a texture to the highlight and to the environment map, if it is used. The alpha channel of the specular map image is ignored.

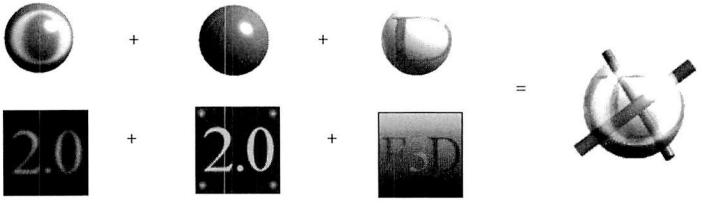
- If the roughness color is dark, the material's highlight is small and intense, giving the surface a glossy finish. A light roughness color diffuses the highlight, giving the surface a matte finish. By using a color for roughness, you can control the highlight size for individual colors. Use this control to create colored halos around highlights. By using a roughness map you can create a surface, like granite, whose roughness varies. The alpha channel of the roughness map image is ignored.



- A dark transparency color produces a material that is only slightly transparent. When the transparency color is lighter, the material is more transparent. The transparency color of the material also affects the color of objects seen through it. When a transparency map is used, the colors in the map determine the amount of transparency at each pixel. Use this effect, coupled with colored lights, to create a stained glass look. Transparency affects the alpha channel of the final rendered image.

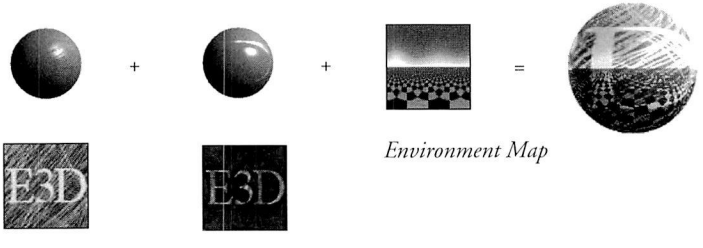
- The luminosity color determines the overall brightness of the surface. Light luminosity colors make the object appear to glow, regardless of the amount of light falling on the surface. A dark luminosity color has no affect. When you use a map to determine luminosity, the map colors determine the luminosity of the surface at each pixel. Bright areas of the map produce a glowing effect from pixels in that area. The alpha channel of the luminosity map image is ignored.

- Bump maps create bumpy textures using the gray scale value of the image as if it were the height of the surface texture.



Luminosity Map *Bump Map* *Transparency Map*

- If you create a highly reflective surface using a combination of a specular map and specular properties, you can choose an environment map as well and see it reflected in the surface. The specular map modifies the environment map.



Environment Map

Specular Map *Roughness Map*

Note: Materials made with Mondo Maps use the same mapping type, tiling, and flip settings for all maps except the environment map. Therefore it is best to get all the maps oriented to the object before turning on tiling in order to ensure more predictable results.

To see an animation that demonstrates the use of an environment map and a specular map:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Mondo Map" movie.

To see an animation that demonstrates the use of a bump map and a roughness map:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Mondo Map 2" movie.

Creating effects with the alpha channel

You can use the alpha channel options in materials customized from Generic+Texture or Mondo Map to create a number of effects. Remember to create the texture maps you use for these effects as 32-bit images so the pixels have alpha channels with values other than 1.

Override Alpha—ignores alpha information for this texture map. This is useful if you are using a texture map that has alpha information that you don't want to use.

Composite over Color—uses the alpha channel to composite the texture map image over the surface color. The surface color shows through wherever the alpha channel is laid in the texture map.

Existence of Surface—makes the texture map and the object that it covers completely disappear where the alpha value is zero (completely transparent). You can further control the transparency of the remaining surface using the transparency color.

Luminance Map—produces a glow in every pixel proportional to its alpha value. High alpha values produce bright glows. This effect makes the surface appear lit, independent of any light. It is combined with the luminance map, if you use one.

Transparency Map—uses the alpha channel as a monochrome transparency. This creates an effect rather like that of Existence of Surface except that the surface shading is preserved even where the alpha channel is black and the surface is transparent. It is combined with the transparency map, if you use one.

To see an animation that demonstrates the alpha channel effects in use:

- Double-click the Learning Viewer in the Learning folder on your application CD and watch the "Generic+Texture" movie.

Using mapping features with solid materials

All materials, whether they are texture map materials or solid materials, are affected by the mapping type. By default, texture maps use the intrinsic mapping type and solid materials use the projective mapping type. By changing its mapping type to intrinsic, you can use any solid material like a texture map.

To change the mapping type of a solid material:

1. **Select an object in the workspace that has a solid material.**
2. **Choose Objects from the Window menu.**
   This opens the Objects browser.
3. **Choose the Info page and choose a new mapping type from the mapping Type pop-up.**
   To use the solid material as a surface material, like a texture map, choose Intrinsic from the pop-up. You can then use the Intrinsic Texture Placement tool to interactively place the solid material on the object's surface like a texture map. For more information, see "Choosing a mapping type and placing texture maps on objects" on page 378.

Note: To import Extreme 3D 1.0 files into Extreme 3D 2.0 and have the solid materials have the same look, select the object that has a solid material and follow the previous procedure, setting the mapping type to Default.

If you map a solid material using the projective mapping type, the material projects through the object from the direction and at the angle you specify.

If you map a solid material using the intrinsic mapping type, the material stretches over the surface like a texture map.

Note: You can also tile and flip solid materials. The effect of tiling and flipping on solid materials depends on their mapping type. When you use the projective mapping type, the region of the material that corresponds to the object's 0-1 mapping coordinates is repeated all over the surface. To see more or less within each tile, scale the material pattern. When you use intrinsic mapping type, a section of the material repeats itself over the entire surface.

Managing and organizing materials and maps

By organizing the Materials browser and using the catalog feature of Extreme 3D, you can create strategies for managing all the maps and materials you generate for your scene. If you name and organize your materials in the Materials browser, your organizational strategy is easier to maintain. This section describes the organizational strategies of:

- Finding all objects that have a certain material
- Renaming materials in the browser
- Rearranging materials in the browser
- Removing materials from the browser
- Using materials catalogs
- Using the preset materials
- Saving scenes and textures for production work

Finding all objects that have a certain material

Sometimes it is useful to find all the objects in your scene that are assigned a specific material, such as when you want to assign those objects a different material.

To find all the objects in a scene that are assigned a specific material:

1. **Choose Materials from the Window menu to open the Materials browser.**
2. **In the Materials in Scene list, select the name of the material you want to find.**
3. **Click the Select Applied button.**
   All the objects that are assigned that material are selected in the workspace.

Renaming materials in the browser

If you give your materials names that are descriptive when you customize them, it is easier to remember what objects they are applied to or how you use them. This also makes it easier to share materials across scenes.

To rename materials in the Materials browser:

1. **Decide on a naming strategy, for example descriptive names or a name and number system.**
2. **Choose Materials from the Window menu to open the Materials browser.**
3. **From the Materials in Scene list, select the material you want to rename.**
   When a material is selected its name appears in the text field below the Materials in Scene list.
4. **Type a new name in the text field and press Enter.**
   The material is renamed.

Rearranging materials in the browser

Once your materials are named, you can arrange your materials in a particular order in the Materials browser to help you locate them.

To rearrange materials in the Materials browser:

1. **Decide on an organizational strategy.**
2. **Choose Materials from the Window menu to open the Materials browser.**
3. **From the Materials in Scene list, select the name of the material you want to rearrange and drag it to the place in the list where you want it to be.**

Note: New materials are added to the top of the list, so you may need to rearrange the list to maintain any organizational system you create.

Removing materials in the browser

To maintain your organizational strategy and optimize working with materials, delete those materials that you are no longer using.

To delete a material from the scene:

1. **Choose Materials from the Window menu to open the Materials browser.**
2. **From the Materials in Scene list, select the name of the material you want to delete.**
3. **Press the Delete key or choose Cut from the Edit menu.**

When you delete materials customized from the Generic+Texture, Mondo Map, or Chrome+Glass materials, the associated texture maps are not deleted. You might want to delete the maps as well because they take up slightly more space than the original graphic and can easily be regenerated from the graphic if you need them.

To delete the maps used by the Generic+Texture, Mondo Map, or Chrome+Glass materials:

1 **Find the folder that contains your texture maps.**
The default texture catalog is stored inside the folder that contains your Extreme 3D application. Navigate to this folder, then locate a folder named Scripts and inside it a folder named Material.

2 **Delete from the system the texture map that you no longer want.**

Note: If you open a file that contains a material referring to a missing TEX file, you are prompted to search for the file. Use the Select Catalog button in the Materials browser to navigate to the TEX file's location. When you choose Open, the TEX file is copied to the Material folder inside the Scripts folder. When a TEX file is in any location other than the Scripts folder, it does not show up by name in the directory list.

Using materials catalogs

When you customize a material from one of the default material types, Extreme 3D saves it in the scene file. However, if you want to use a material in a different scene, you can create your own catalogs or save to other catalogs, such as the one containing the material presets that come with Extreme 3D.

To save a customized material for use in other scenes:

1 **From the Materials in Scene list, select the material you want to save for use in other scenes.**

2 **Click the right double-arrow button.**
This moves the material into the Materials in Catalog list. Cataloged materials are saved as MAT files in the Material folder inside the Scripts folder and they appear in the Materials in Catalog list the next time you start Extreme 3D. (Bitmapped graphics associated with texture map materials are also saved in this folder as TEX files.) If you save materials to another catalog, they appear in the Materials in Catalog list when you select that catalog. If the current catalog exists on a CD or other nonwritable media, the double-arrow button is dimmed.

To open another materials catalog:

1 **Click the Select Catalog button in the Materials browser.**
This opens the standard directory dialog box allowing you to search your system for additional catalogs, such as the presets catalog that are installed with Extreme 3D.

2 **Search your system for additional catalogs and open the one you want.**

To create a new catalog:

1 **Make a new folder on your system wherever you want the new catalog to be saved.**

2 **Click the Select Catalog button.**
This opens the standard directory dialog box so that you can specify a new catalog location.

3 **Search your system for the new catalog and open it.**
All materials that you add to the Materials in Catalog list in the Materials browser are copied into the new catalog's folder.

To remove a material from a catalog:

1 **Find the folder that contains your material catalog.**
For the default materials catalog, find the folder that contains your Extreme 3D application. Within this folder locate the Scripts folder and then the Material folder inside that.

2 **Delete the material (MAT file) that you no longer want.**

Using the preset materials

A collection of over 200 preset materials that were created using the nine default material types is installed to your computer when you install Extreme 3D.

To use the preset materials in your scene:

1 **In the Materials browser, click the Select Catalog button.**
This opens the standard directory dialog box allowing you to search your system for additional catalogs.

2 **Find the folder named Presets.**

3 **Choose the folder in Material that contains the presets you want.**
The presets catalog you choose becomes your current catalog and all the materials in it are available for your use. To learn how to save materials you customize from the presets to a catalog, see "Using materials catalogs" on page 393.

Using materials catalogs with network rendering

Network rendering copies all texture files (TEX) to the specific job folder, which is saved in a location you specify by the Network Rendering Path preference. All machines assigned to the rendering task are set to look in this folder for TEX files. The materials that you customize for your scene are saved as MAT files with the scene file (E3D).

Saving scenes and textures for production work

If you are working in a group, or passing scene files to others, it can be useful to gather all the materials and textures you need together with the scene file into one folder.

To save the scene and all its texture map files in one folder:

1 **Choose Collect Files from the File menu.**

2 **Use the standard system dialog box to specify or create a folder.**
Extreme 3D saves the current scene, including its materials, lights, and geometry in one file and copies all TEX files to the folder you name.

Animating lights and materials

Lights that are represented as objects can be animated like any other object in Extreme 3D. In addition, you can animate any light or material property that appears in the Lights or Material editor.

Animating omni lights and spotlights in the workspace

You can use the same animation techniques to animate the position and orientation of light objects as you would to animate any object. Keep in mind that ambient and omni lights do not have orientations and ignore the orientation settings on the Objects and Lights browsers. You can also make use of links and watch links to animate your lights.

This section describes:

- Animating light positions and orientations
- Linking lights to objects
- Animating lights to follow objects

Animating light positions and orientations

Use the arrow tool, arrow (nudge) keys, and the Lights and Objects browsers to animate the positions and orientations of light objects.

To animate the position or orientation of a light object in the workspace:

1. **Select the light object you want to animate.**
2. **In the current time field of the animation controls, type the time at which you want the movement to be completed and press Enter.**
3. **Then, either:**
   - Choose the arrow tool and move the light object in the workspace. Use the F3 and F4 keys (Windows) or the Option and Command keys (Macintosh) to reorient the light object. Use the arrow keys to nudge the object's position or orientation.
   - Or use the position fields, pointer, or trackball in the Lights browser or Objects browser to change the light's position or orientation.

To continue animating the light object, increase the current time value in the animation controls to the next time at which you want a movement to be completed and position or orient the light object again.

Linking lights to objects

You can use the linking tools with light objects. If you want a light fixture to appear in your scene, a light in the end of a flashlight, for example, or a light in a street lamp, you can model the fixture and then link the light to it. For more information, see "Creating animations using parent-child links" in Chapter Four.

To create a realistic effect with spotlights, you might want to position and orient the light object first. Then align it to the light fixture and perform the link.

To link and align a spotlight object to an object in the scene:

1. **Select the light object you want to align and link.**
2. **Choose the arrow tool or use the pointer in the Lights browser to orient the light object so that it shines in the direction the light fixture is aimed.**
3. **Choose the free link tool and free link the light object to the light fixture model.**
4. **Select the light object and choose Align from the Object menu, then choose Position to align the light object's position to that of the light fixture.**
5. **If you want to be able to position and orient the light object by moving the light fixture, change the link between the light object and the light fixture to a lock link.**

Tip: If you use several lights in one place to create an effect, for example, a distant light with a shadow and one without to create more defined shadows, you can link the light objects to each other so they always move together when you animate them.

Animating lights to follow objects

You can also use the watch link tool to animate lights by following objects in the scene. This is a good way to create a follow spot and is also useful for making sure a light is properly aimed at the object you want it to illuminate.

To watch link a light object and animate it:

1. **Choose the watch link tool from the tool palette.**
2. **Drag a line from the light object you want to be the watcher to the object you want to be the target.**
3. **Choose Animation Controls from the Animate menu to open the animation controls and set the current time field to the time or frame at which you want your next keyframe.**

4 **Select the target object and move it to a new position in the workspace.**
Selecting and moving the target object selects and reorients the watcher as well.

5 **Repeat steps 3 and 4 until you have completed the animation you want.**

For more about animating watch links, see "Creating a watch-linked animation" in Chapter Four.

Note: All the animation techniques described above can also be performed in the score. For more information, see "Animating in the score" in Chapter Four.

Animating texture maps in the workspace

You can animate both the placement and the orientation of texture maps on objects. Using this feature, you can achieve effects like a label wrapping itself around a bottle. You cannot animate a change in mapping types, tiling, or flipping of texture maps.

To animate the placement or orientation of a texture map:

1 **At time zero assign, place, and orient a texture map to an object.**
See "Using texture maps" on page 375.

2 **Choose Score from the Animate menu to open the score.**

3 **Set the current time field or drag the playback head to the time at which you want to animate the texture map placement or orientation to end.**

4 **Choose the texture map placement tool or material orientation tool you want.**
If you choose a texture map placement tool that is different from the one you used at time zero, the mapping type for the object changes for the whole animation.

5 **In the workspace, place or orient the map to a new position or orientation on the object.**

Note: Texture map placement or orientation can also be animated in the workspace using the animation controls to set the current time field to times at which you want keyframes.

Animating lights and materials' properties

Animating the properties of lights and materials is no different than animating any other property in Extreme 3D. You can animate all lights and materials properties in the score, or you can use the Lights or Materials browsers to create or change the animation values of keyframes for properties. By using the browsers to change values, you can take advantage of the Update Scene and Preview buttons to check your changes.

To change the animation value of a keyframe for a light or material property:

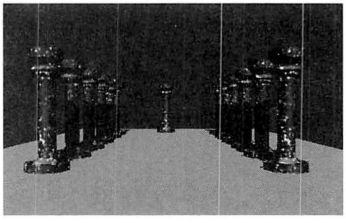
1. **Choose Score from the Animate menu to open the score.**
2. **Select the property track that contains the keyframe you want to change.**
3. **Set the current time field or drag the playback head to the time at which you want a keyframe value to change.**
   The entry fields in the score above the timeline are dynamic and become text entry fields, sliders, or color swatches depending on the property whose track is currently selected.
4. **Then, either:**
   - Use the entry field to change the keyframe's value.
   - Or change the value in the appropriate field of the Lights or Materials browser.

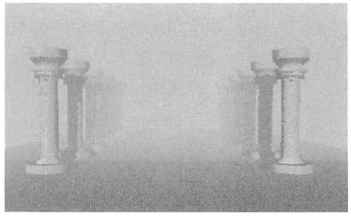
For more information about inserting new keyframes, deleting keyframes, and changing the time values of keyframes see "Animating in the score" in Chapter Four. For more information about what values to use, see "Editing the basic properties of lights" on page 352 and "Customizing materials" on page 367.

Creating fog

In addition to lighting objects with the basic light types and creating materials that compliment your design, you can create mood or atmosphere using the global effect of fog. As the name global effect implies, fog affects the entire scene, including the look of the lights and materials.

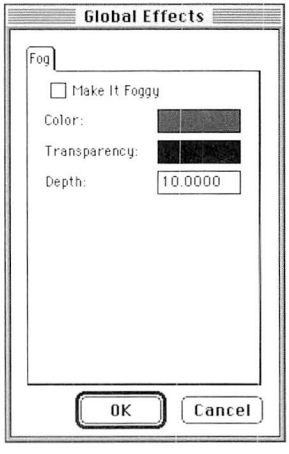
Fog adds a color, a transparency, and a depth value to the shading calculation. Fog color is added to your scene depending on how far away the objects are. The transparency color absorbs the color of objects in a similar way. Experiment with changing your light colors, materials, and fog values to see how these properties relate to one another. When you add fog to the scene, it affects all views. Fog only appears in final renders.





To add fog to the scene:

1 **Choose Global Effects from the Render menu.**



2 **Check the Make it Foggy check box to include the fog settings in the shading calculation of the scene.**
You can uncheck this check box to render the scene without fog for quick test renders and retain fog settings.

3 **Select the fog color by clicking the Color chip.**
The Color defines the color of the fog when it is totally saturated, as it is when it is over an empty background. This color appears more intense the further away the object is. The default color is light blue. To achieve a realistic looking fog, set this color close to the colors of any ambient lights in the scene.

4 **Select the Transparency color by clicking the Transparency chip.**
This color determines how the fog absorbs light from objects. For example, if the transparency color is red, the red color passes through the fog and affects the color of the fog, while blue and green hues are mostly absorbed by the fog. The transparency color affects objects that are farther away from the eye point of the view or camera more intensely.

5 **Select the fog's Depth.**
This is the distance at which the fog's density is approximately 63 percent. The density of the fog increases as it moves farther away from the eye point of the view or camera. The units used for the Depth Value are set in the Units dialog box on the Object menu.

6 **After adding fog to the scene, choose Render to Screen from the Render menu.**
This command uses the final renderer and the current options in the Final Render Setup dialog box to render the current window to the screen. If fog is part of the scene, it is added to the final render. For more information about rendering to screen, see "Rendering to the screen" in Chapter Six.

Tip: When you use fog, the fog color is added to the background color, affecting the color of the background. If you use a black background, the fog will also be black.

Note: The intensity of visible light cones of spotlights is not diminished by the fog.

Settings that affect lighting

Because lighting is an interaction of the properties of lights, the objects they shine upon, and the materials assigned to those objects, there are a number of settings that affect the way lights look in your Extreme 3D scene. For example, to see a number of lighting effects you need to use a view that has perspective, not an orthographic view. The objects settings that affect lights include shading calculations, polygon settings, and final render settings. These are discussed in the following sections.

Tip: You might not see the effects of these settings on the objects until you perform a final render. That's why it's a good idea to perform test renders periodically as you develop your scenes.

Note: Light settings affect both the objects in the workspace and the preview window in the Materials browser.

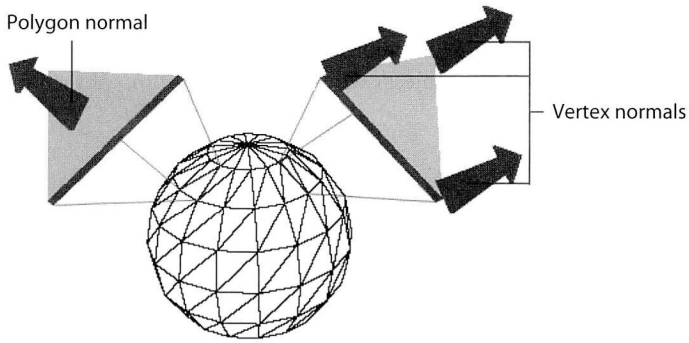
How render styles affect lighting

You can think of shading calculations as those techniques used by Extreme 3D to indicate the light's color, intensity, fall off, and shadows. The calculations that Extreme 3D uses depend, in part, on the stage of work you are at and what settings you're using at that particular stage. You can compare these different shading calculations to the way an artist works, starting from thumbnails and pencil sketches to finishing a final work full of light, shadows, and details.

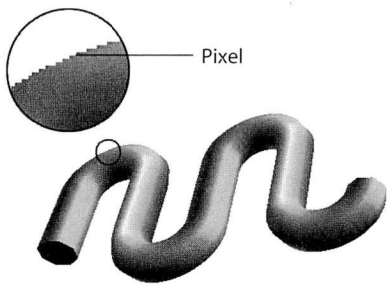
Instead of using shading techniques like pencil lead or paint, Extreme 3D shades objects by calculating polygon normals, vertex normals, and pixel color. The different render styles each manipulate polygon normals, vertex normals, and color slightly differently to provide you with performance flexibility. The render style you select for each object or for the current window determines the complexity of the shading techniques used to render the scene. Simpler shading, like wireframe, is much faster than complex shading, like smooth and shader. This lets you do everything from quickly "sketching" the look of your lights in faceted wireframe to creating a final rendering of your scene that includes all the effects of your lighting design using shader render style. For more information about rendering, see Chapter Six, "Rendering."

How Extreme 3D uses normals in each of the render styles

Each polygon in an object has one polygon normal and a vertex normal for each of its corners. A ***normal*** is a line perpendicular to a polygon's vertex or surface that is used to perform shading and smoothing calculations. To visualize these normals, imagine drawing the object's polymesh on its surface and placing a small arrow that is perpendicular to the polygon's face in the center of each polygon in the polymesh. These arrows are the ***polygon normals***. Then imagine drawing a similar arrow at each of the corners of each polygon. These arrows are the ***vertex normals***.



The process of rendering is one of converting the information provided by the geometry of the object and the calculation of its normals into the ***pixels*** that comprise a two-dimensional image. A pixel is the smallest picture element a computer can display. To understand how pixels make up complex pictures, compare them to the dots of paint in an impressionistic painting or to the dots in a newspaper photograph.

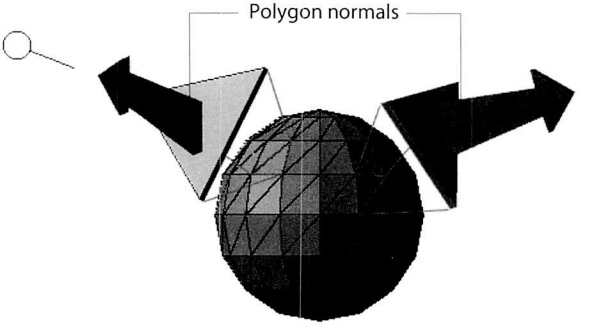


Point, Wireframe, Fast Wireframe, and Hidden Wireframe render styles

In these wireframe render styles, the object is drawn as lines connecting the polygon vertices, which reveals the underlying mesh of polygons used to calculate the object's surface in more complex render styles. There are no surfaces in wireframe, so no shading calculations are used.

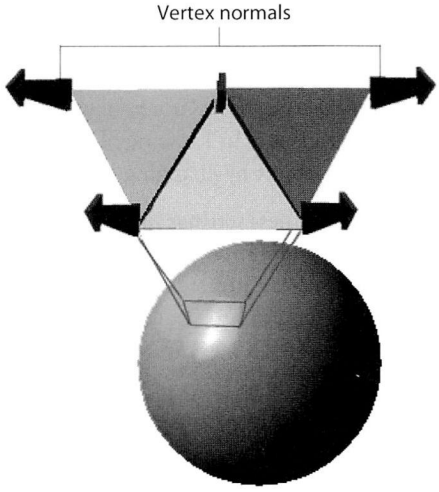
Faceted and Faceted Wireframe render styles

In both faceted and faceted wireframe render styles, each polygon is shaded with a single color. Polygons whose normals point towards a light are illuminated by it and polygons whose normals point away receive no light and are dark. In faceted wireframe, the object's wireframe drawn on top of the polygon surfaces.



Smooth render style

In smooth render style, the light is calculated at each vertex instead of just once per polygon. Then colors are interpolated between the edges of polygons to blend the shading. This is called ***Gouraud shading***.



Shader render style

Shader render style uses Gouraud shading, like smooth render style, during interactive rendering. However, it does texture mapping, which smooth render style does not.

During final render, shader render style uses ***Phong shading***. This technique uses vertex normals in much the same way as Gouraud shading, but normals are interpolated to determine the light intensity at every pixel instead of at every vertex. Phong shading is more time consuming than any of the other shading calculations, but its method of calculation allows it to render texture maps, transparencies, and shadows, and to represent highlights more realistically.

Note: The quality of highlights might look different depending on the render style you choose and whether you are using the final renderer or the interactive renderer.

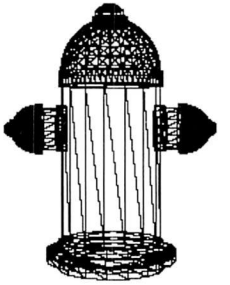
For more information about setting window render styles, see Chapter Six, "Rendering." For more information about setting object render styles, see the Reference section of the Extreme 3D Help system.

How smoothness settings affect lighting

The number of polygons that represent an object's surface, as seen when you choose the wireframe render style, is often referred to as the ***polygon resolution*** of an object. Polygon resolution has several implications for lighting.

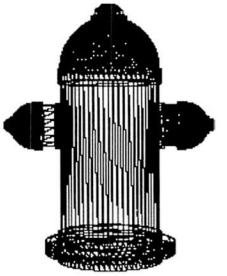
Because shading calculations use polygon normals and vertex normals, changing the polygon resolution of an object also changes the number of polygon normals and vertex normals that object has. The more polygons an object has, the more refined its shading calculations are. In Extreme 3D, you can determine the polygon resolution for each object by changing its smoothness settings.

There are two types of smoothness settings in Extreme 3D, adaptive smoothing and uniform smoothing. The ***adaptive smoothing*** settings interpret the surface of a model as polygons that are concentrated more in areas where the surface bends or changes direction rather than in broad or flat expanses of surface.



Low adaptive smoothing: interactive render

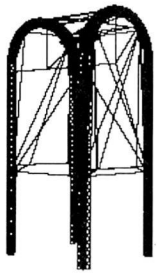
Low adaptive smoothing: final render



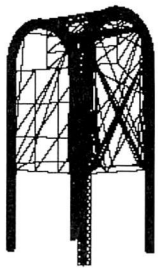
High adaptive smoothing: interactive render

High adaptive smoothing: final render

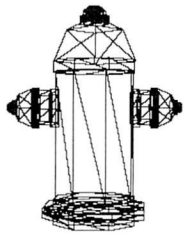
The ***uniform smoothing*** settings convert the surface of a model into a grid work of evenly spaced polygons. The greater the number of subdivisions, the finer the mesh and the smoother the rendered object will appear. Objects with a finer mesh take more time to render. This is useful for reducing the polygon resolution for rectilinear objects or for creating faceted surfaces. For more information about setting smoothness, see the Reference section of the Extreme 3D Help system and "Adjusting smoothness settings" in Chapter Six.



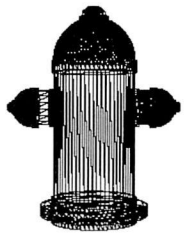
Low uniform smoothing: interactive render



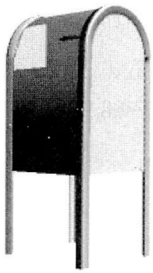
High uniform smoothing: interactive render



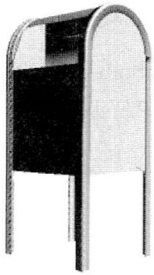
Low uniform smoothing: interactive render



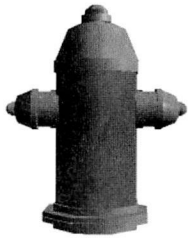
High uniform smoothing: interactive render



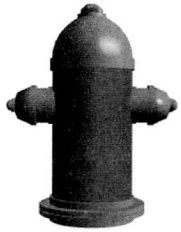
Low uniform smoothing: final render



High uniform smoothing: final render



Low uniform smoothing: final render



High uniform smoothing: final render

Tip: Each object has an Interactive Render Setting and a Final Render Setting. Usually you want your interactive settings to have smaller values so objects can be drawn faster in the workspace. Final render settings should be high enough to produce the level of shading refinement you want for your final image. For more information, see Chapter Six, "Rendering."

How front and back facing polygons affect lighting

In addition to being used to calculate shading, polygon normals are also used to determine whether polygons are front facing or back facing. The ***front-facing polygons*** are those whose normals point towards you, relative to the current view; ***back-facing polygons*** are those whose normals point away from you, relative to the current view.

Sometimes you might not want to render back facing polygons, for example if your object is opaque. This can speed up rendering because you don't render the faces that aren't seen. However, some modeling operations, like separating end caps, may expose polygons that were created as back-facing polygons. When this occurs, part of the model may seem to disappear and you might think you need to adjust your light. This is because, relative to the current view, its polygon normals are pointed away from the view. Before adjusting the light, try toggling through the display polygon choices to ascertain the status of the polygon normals and choose a new polygon display status if necessary.

Tip: For transparent objects, set Display Polygons to Both to render the back surface through the front one.

Note: If you have a model that appears to have its back-facing polygons showing but Extreme 3D indicates that its front-facing polygons are toggled on, its polygon normals may be pointing in the wrong direction. This leads to undesirable lighting effects. To fix this, select the model and choose Control Points from the Object menu, and then choose Reverse Ordering.

For more information about changing polygon display, see the Reference section of the Extreme 3D Help system and "Optimizing objects for rendering" in Chapter Six.

How final render settings affect lighting

The Final Render Setup dialog box has several options that affect the look of the lighting design of your scene when it is rendered to screen or to disk as a final render.

Quality—This option adjusts several aspects of final image quality. Its primary function is to set the ***anti-aliasing*** filter. Anti-aliasing smooths the edge staircasing effect that occurs naturally when edges of objects are rendered as pixels.

Final Smoothness Settings—The final smoothness settings that you assign to your objects in the Adaptive Smoothing or Uniform Smoothing dialog boxes are not used during rendering unless this option is checked.

Render Shadows—Each distant light and spotlight can cast shadows. Even if you have turned this property on for some or all of your distant lights and spotlights, the shadows will not be rendered unless you check this option.

Transparency in Shadows—Any transparent material can also be transparent to light. When you render transparency in shadows, any part of an object's surface that is covered by a transparent material does not cast a shadow. If you want this effect, be sure to check the Transparency in Shadows check box.

Alpha Channel Output—The kind of alpha output you choose is determined by how you plan to use your final image. Use Standard if you are going to composite the output outside of Extreme 3D and you're not sure which one to use. Images look correct for print or processing in an image manipulation application if you use Standard.

Gamma Correction—Choose the Gamma Correction that is suited to the output delivery you anticipate. Colors will look correct on video or film if you choose one of those options. Gamma correction can also be useful as an effect. It controls the contrast, brightness, and overall mood of the scene. Use Punch Up to manipulate the gamma rather than correct it. For print and digital video output, None is best.

To learn how to perform a final render that includes all your lighting and material effects, see "Setting up for a final render" and "Rendering to the screen" or "Rendering to disk" in Chapter Six.

6 Chapter Six
Rendering

In some ways rendering is the final step in the creative process—you get to view the results of your efforts and complete the project. Rendering is also done throughout the creative process, to check lights and materials, scene composition, or animation. For example, you can render part of the scene to disk in wireframe mode to preview the animation or you can render the current window to the screen to see how the materials and lights look. This chapter discusses everything you need to know about rendering in Extreme 3D, including the following:

- **Rendering concepts**—discusses the different types of interactive renderers in Extreme 3D. It also explains the difference between interactive and final rendering and the options that affect each one.
- **Preparing to render**—steps you through the process of preparing the scene for different rendering tasks.
- **Setting up for a final render**—explains the options that affect a final render.
- **Rendering to the screen**—explains how to do a final render to the screen.
- **Rendering to disk**—explains how to render either test or final scenes to disk, and how to render high-resolution images in large sizes (up to 8K x 8K pixels).
- **Network rendering**—discusses how to render a batch of scenes to your local hard disk or set up multiple machines on a network to share rendering tasks.

Rendering concepts

There are two different types of renderers in Extreme 3D: ***interactive*** and ***final.*** This section explains the differences between interactive and final rendering, and explains which options you can modify for each. This section also provides a table that summarizes how to optimize rendering for different renderers. It contains these sections:

- Types of interactive renderers
- Interactive rendering
- Final rendering
- Optimizing rendering

Types of interactive renderers

Interactive renderers are optimized for speed rather than image fidelity. They are used whenever speed is the overriding concern, such as during modeling and animation preview. Your system may have two interactive renderers available. (Select the current interactive renderer in the Window Setup dialog box on the Window menu.)

- The internal interactive renderer

  This interactive renderer, available on all Extreme 3D systems, is Extreme 3D's custom internal renderer. It does not take advantage of add-on 3D acceleration hardware. The internal renderer does support cross-platform image compatibility for network rendering using the interactive renderer.

- A third-party interactive software renderer, such as:

  - The Direct3D interactive renderer, available on Windows 95 only
  - The QuickDraw 3D interactive renderer on the Macintosh

  Both of these renderers speed up interactive rendering and can take advantage of add-on 3D acceleration hardware if available. These renderers also offer some additional functionality, such as:

  - An additional rendering style, called Point
  - Shading for the Wireframe render style
  - Texture mapping for Wireframe and better render styles

To use the either Direct3D or QuickDraw 3D renderer, the appropriate software renderer must be installed in your system.

Note: See the 3D Acceleration page of the Preferences dialog box for options that affect interactive rendering.

Interactive rendering

The current interactive renderer is always active while you are working in Extreme 3D. You always see the results of interactive rendering unless you specifically choose to do a final render. The interactive renderer creates an approximation of the scene. It works much more quickly than the final renderer. With this renderer, you can see shapes and colors, but some of the scene's details, like shadows and fog, are not rendered.

You can also use the interactive renderer to render a scene to disk. This is useful for rendering animation tests, where you want to quickly check motion without rendering final lights, materials, or final smoothness settings.

There are two ways to render the scene using an interactive renderer:

- Create a scene or preview animation (the interactive renderer is used by default to display the scene on screen).
- Render to disk with the interactive renderer.

There are a few options in Extreme 3D that you can specifically set for interactive rendering:

- **The render style for the current window**—the render style used by the interactive renderer (Shader, Smooth, and so on) is determined by the Max Render Style that is set for the current window in the Window Setup dialog box. In general, the better render styles take longer to render but give a more accurate representation of the image.

  The Max Render Style determines the best kind of shading technique that the interactive renderer uses in the scene. Individual objects use their own object render style unless that style is better than the Max Render Style for the window.

  All non-surface objects such as the working plane, construction objects, light objects, and the camera appear in the scene when it is rendered in interactive mode. When the internal renderer is active, the object render style and the Max Render Style for the current window must be Shader to see texture maps and materials during interactive rendering. (When either the Direct3D (Windows 95 only) or QuickDraw 3D (Macintosh) renderer is active, texture maps are visible in the Wireframe render style and better.)

Note: The Fast Wireframe Max Render Style is a special type of internal interactive renderer that is designed for previewing animation in the workspace. When the current window's render style is set to Fast Wireframe (when using the internal interactive renderer only) the Render to Disk and Final Render to Screen commands are not available.

- **Smoothness settings for each object**—smoothness settings determine the model resolution (or polygon count) of each object. Each object in the scene has both interactive and final smoothness settings assigned to it. The interactive settings are always used for interactive rendering. Smoothness settings are set in either the Adaptive Smoothing or Uniform Smoothing dialog box.

Interactive rendering does not render the following details. These options are available only in final render. *(Items marked with an * are available with some 3D acceleration cards.)*

- Phong shading
- Surface details of materials
- Fog
- Shadows and dust cones
- Object transparency*
- Anti-aliasing
- Texture filtering (anti-aliasing for texture maps)*
- Alpha channel options in texture mapping
- Bump mapping
- Reflective surfaces

Final rendering

Final rendering automatically uses the best render style for the entire scene, (regardless of the render style for the window or individual objects) and calculates all materials and effects. It takes longer to render with the final renderer than with any of the interactive renderers. The time difference varies greatly depending on how complicated the scene is, the effects used, and which rendering options are selected. (It is possible, for example, to speed up rendering time by rendering a scene with the final renderer without calculating shadows.)

There are two ways to do a final render:

- Use the Final Render to Screen command to render the current window at the current frame. This is a good way to check materials, lighting effects, fog, and so on.
- Render to Disk with the final renderer.

There are several Final Render Setup options. They affect:

- **The amount of anti-aliasing**—The scene is anti-aliased during final render if the Quality setting is better than Low. This is set in the Final Render Setup dialog box using the Quality pop-up. Anti-aliasing smooths out the edge staircasing effect that occurs naturally when edges of objects are rendered as pixels. You can control the quality level of anti-aliasing, but rendering time increases as quality increases. (Extreme 3D uses adaptive anti-aliasing, which greatly improves performance by determining which pixels need additional smoothing. With this process, rendering time does not increase linearly. For example, the Better (4x4) Quality option does not takes sixteen times longer to render than the Low (1x1) option.)

- **Smoothness settings**—Each object in the scene has both Interactive and Final smoothness settings assigned to it. You can use either smoothness setting during a final render. Smoothness settings are determined by one of two smoothness settings dialog boxes and the Final Smoothness Settings check box in the Final Render Setup dialog box. Smoothness settings determine the model resolution (or polygon count) for each object.

- **Whether shadows are rendered**—Lights that have shadows (spotlights and distant lights) can be rendered with or without shadows in final render. Shadows increase rendering time. Shadows can be turned off on a light-by-light basis in the Lights editor or all at once using the Render Shadows check box in the Final Render Setup dialog box.

- **Whether shadows are rendered for transparencies**—When Transparency in Shadows is checked, shadows in the scene are calculated based on the amount of transparency in each material. When Transparency in shadows is on, each pixel is checked for transparency during rendering, so rendering requires more time. Turn this option off to speed up rendering for test rendering, or when transparent shadows are not needed.

- **The type of alpha channel for the final rendered image**—Controls whether the alpha channel in the final image is Pre-Multiplied or Standard. Pre-Multiplied retains aliasing calculated for the image during rendering. It may be the preferred format if you don't need to do additional editing or compositing with this image in an image editing or digital video application. Standard removes anti-aliased colors from the image. This is the alpha style used by popular image editing applications.

The following effects are calculated automatically for a final render if included in the scene:

- Fog, as set in the Global Effects dialog box.
- Transparency, as set on a per-material basis in the Materials browser. Transparency information is stored in the alpha channel of each image or frame of 32-bit output.
- Reflective surfaces, as set on a per-material basis in the Materials browser.

Optimizing rendering

The following table summarizes the options available for both interactive and final rendering. Read the sections that follow to learn more about these options.

To render:	Final renderer	Interactive renderers
Shadows	Turn on shadows in individual lights and select Render Shadows in Final Render Setup	Not available
Dust shadows	Turn on dust shadows in individual spotlights and select Render Shadows in Final Render Setup	Not available
Transparency in shadows	Cast lights with shadows onto objects with at least 50% transparency; select Render Shadows in Final Render Setup	Not available
Fog	Select and set up in Global Effects	Not available
With anti-aliasing	Select Quality in Final Render Setup	Not available
Transparency attribute in materials	Automatic (based on materials settings)	Internal: Not available Direct3D and QuickDraw 3D: Available with some 3D add-on hardware
Luminosity attribute in materials	Automatic (based on materials settings)	Automatic
Reflective materials	Automatic (based on materials settings)	Not available
Final smoothness settings	Select Final Smoothness Settings in Final Render Setup	Not available
Interactive smoothness settings	Deselect Final Smoothness Settings in Final Render Setup	Automatic
Object render style and current Max Render Style	Not available	Automatic
Background color/ image	Automatic	Automatic
Best render style	Automatic	Set Max Render Style to Shader
Texture maps	Automatic	Internal: Set Max Render Style to Shader Direct3D and QuickDraw 3D: Wireframe and better

Preparing to render

This section describes the options that affect rendering, whether you are doing a final render to screen or rendering to disk with interactive or final settings. Some of the commands discussed work only for final renders, while others apply to both interactive and final renders.

This section describes:

- Checking the Window Setup
- Adjusting smoothness settings
- Optimizing objects for rendering
- Adding a background color and image

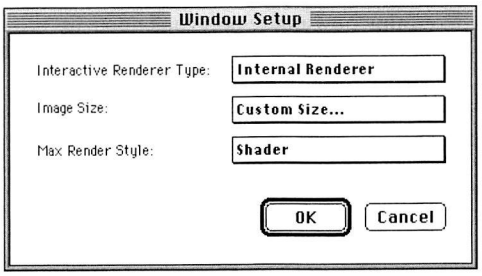
Note: For more information about adding fog to the scene, see "Creating fog" in Chapter Five.

Checking the Window Setup

Normally you set up windows as you are creating scenes and views—long before you begin rendering tasks—but it is important to double-check and possibly adjust these settings before you render to make sure you are rendering the image at the desired size. You can change the window settings for each individual window in a scene.

To adjust window settings:

1 **Select the window in the workspace and choose Window Setup from the Window menu.**
The Window Setup dialog box appears.



2 **Select the Interactive Renderer Type for the window.**
This is the interactive renderer for the currently selected window. This option specifies which renderer to use for drawing interactively in the workspace or rendering to disk with the interactive renderer. It has no effect on final renders. For more information about the types of available interactive renderers, see "Types of interactive renderers" on page 412.

3 **Check the image size for the window you will be rendering and adjust it if necessary.**
To render very large images, leave the window size unchanged in this dialog box and specify a larger size for the final image in the Render to Disk dialog box. For more information, see "High-resolution rendering" on page 438.

4 **Select the Max Render Style for the window and click OK.**
With final rendering, the Max Render Style option does not affect final renders (unless it is set to Fast Wireframe). The Shader render style is automatically used during final render.

Note: The Fast Wireframe Max Render Style is a special type of internal interactive renderer that is designed for previewing animation in the workspace. When the current window's render style is set to Fast Wireframe (when using the internal interactive renderer only), the Render to Disk and Final Render to Screen commands are not available.

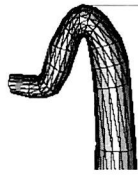
With interactive rendering, this option sets the threshold for the highest render style possible for the window in interactive mode. Individual objects whose render style is higher than the maximum render style for the window are displayed in the window's Max Render Style; otherwise they appear in their own object render style. For descriptions of render styles, see the Reference Section of the Extreme 3D Help system.

Adjusting smoothness settings

Extreme 3D lets you set surface smoothness values for individual objects in the scene and set default smoothness values for new objects. Each new object in Extreme 3D has default smoothness settings associated with it. Smoothness settings determine how many polygons make up the surface of the object; more polygons (higher smoothness settings) create a smoother surface. Smoothness is sometimes referred to as polygon resolution or model resolution.

Note: Surface smoothness settings apply only to objects at the defining geometry or the surface geometry level; you cannot change surface smoothness for mesh or polylist objects (objects that have been simplified twice).

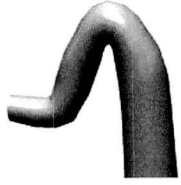
Use the Uniform Smoothing or Adaptive Smoothing commands on the Render menu to change surface smoothness. Uniform smoothing divides the surface into polygons of equal size. Adaptive smoothing also divides the surface into polygons, but creates additional polygons where the object has sharp curves or twists so that those areas of the object look as smooth as the rest of it.



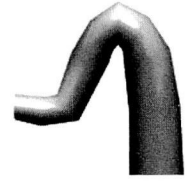
Adaptive smoothing: additional polygons are added where the object twists and turns.

Uniform smoothing: each segment has an equal number of polygons, regardless of the object's shape.

To easily see the effect of adjusting smoothness values, display the object in Faceted Wireframe rendering style.



High adaptive smoothness values



Low adaptive smoothness values

Smoothness settings can make a big difference in the final render, especially for objects that have sharp curves.

All new objects inherit the current smoothness settings when they are created. Adaptive Smoothing is the default, but you can make either one the default. The smoothness command that has a checkmark next to it indicates either the current default smoothing type (when no objects are selected), or the smoothing type applied to the selected object.

Note: Surface smoothness settings are applied only to the edges of end caps.

For each smoothness type there are two sets of smoothness settings—Final and Interactive. This means that you can keep the smoothness values low while working in interactive mode, but use final smoothness settings for the final render. The higher the smoothness settings, the longer it takes to render the scene.

- Interactive Render Settings are used automatically during interactive rendering. (The interactive renderer is always active while you are working on the scene in the workspace or rendering to disk with the interactive renderer.) Low values are recommended for interactive smoothness settings.
- Final Render Settings are used during final render only if the Final Smoothness Settings check box in the Final Render Setup dialog box is checked, otherwise, interactive settings are used. (The final renderer is active when you choose Final Render to Screen or when you render to disk with the Final renderer.) High smoothness values are recommended for final rendering. When using the final renderer to do test renders, leave this option unchecked to speed up rendering time.

Tip: If you want to increase the resolution of an object and increase its number of editable points, increase its surface smoothness before changing its geometry level.

Applying adaptive smoothing

Adaptive smoothing approximates the object's surface as a mesh of triangular polygons. It creates more polygons in areas where the object's surface bends, curves, or changes direction.

When you adjust smoothness values, you can specify surface smoothness for both interactive and final rendering, and set the default values for both. Adaptive is the default smoothing type, which means that new objects automatically inherit the current interactive and final smoothness values when they are created. Uniform smoothing can be assigned as the default, and any object can use uniform smoothing instead of adaptive smoothing. For more information, see "Applying uniform smoothing" on page 424.

To adjust adaptive smoothing:

1 **Choose Adaptive Smoothing from the Render menu.**
Extreme 3D displays the Adaptive Smoothing dialog box.

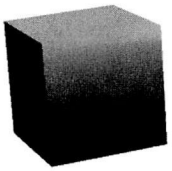
If objects are selected when you open the dialog box, Extreme 3D applies the new values to these objects. You can change the default smoothing type and smoothing values when no objects are selected.

2 **Select either Final Render Settings or Interactive Render Settings to adjust the specified surface smoothness for that rendering type.**

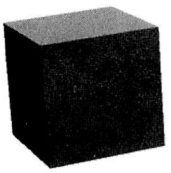
Note: Extreme 3D uses Final Render Settings for final rendering only—and only if Final Smoothness Settings is checked in the Final Render Setup dialog box. For more information, see "Setting up for a final render" on page 429.

3 **Drag the smoothness slider to the desired surface smoothness, or enter a smoothness value between 0 and 1.**
A smooth surface produces higher resolution, but renders considerably slower than a rough surface. You can use a rougher surface for interactive rendering to speed up screen redraw and conserve memory while creating your scene.

4 **Click the Render Edges Sharper check box to make object corners render sharper.**
When this option is checked, Extreme 3D bases the rendering on the object's actual surface geometry rather than the approximation used for the polygon mesh. This gives objects with corners sharper edges. Leave this option off to speed up rendering time.



This object has Render Edges Sharper turned off.



This object has Render Edges Sharper turned on, so the shading is more defined at the object's edges.

5 **To preview the changes to selected objects, click Update.**
Extreme 3D renders the selected object(s) in the workspace with the new values. Final Render Settings also preview, even though the workspace is in interactive render mode. When you close the dialog box after previewing Final Render Settings, the object(s) are redrawn with interactive values.

Tip: During preview, use the Wireframe or Faceted Wireframe render style to quickly see the effect of different surface smoothness levels on objects.

6 **Click OK to save the settings and close the dialog box.**
If no objects are selected when you open the dialog box, no changes are saved when you click OK.

To change the default values for adaptive smoothing, or to make adaptive smoothing the default smoothing type (if it isn't currently):

1 **Do not select an object in the workspace.**

2 **Follow steps 2–4 in the previous procedure.**

3 **Click Default to accept the changes and make the current values the default values.**
Only the default values are modified when you click Default—selected objects are not assigned the new default smoothness values.

Note: Adaptive smoothing is limited in the degree of faceting that it can apply. If this is insufficient, use uniform smoothing, which lets you specify the exact number of rows and columns to apply to an object. (Multiply these two numbers together to calculate the number of polygons for the object.)

Applying uniform smoothing

Uniform smoothing approximates the object's surface as a mesh of regularly spaced quadrilateral polygons.

It lets you specify the number of column and row subdivisions used to create this mesh. The greater the number of subdivisions, the finer the mesh. The following figure illustrates different mesh densities for the same objects.

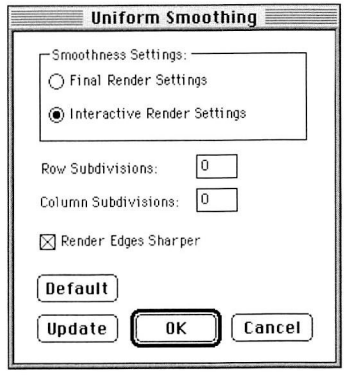
The football was rendered using successively higher uniform smoothing values. It is much smoother and more realistic with a high setting. (High smoothness values require more time and memory to render than low smoothness values.)

When you adjust smoothness values, you can specify surface smoothness for both interactive and final rendering and set the default values for both. Although Adaptive is the default smoothing type, which means that new objects automatically inherit both the interactive and final adaptive smoothing values, you can assign Uniform Smoothing to any object, or assign Uniform Smoothing as the default smoothing type.

To assign uniform smoothing to an object:

1 **Select the object.**

2 **Choose Uniform Smoothing from the Render menu.**
Extreme 3D displays the Uniform Smoothing dialog box.

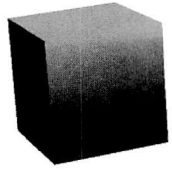


3 **Select either Final Render Settings or Interactive Render Settings to adjust the specified surface smoothness for that rendering type.**

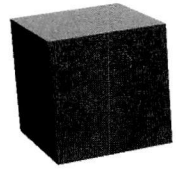
Note: Extreme 3D uses Final Render Settings for final rendering only—and only if Final Smoothness Settings is checked in the Final Render Setup dialog box. For more information, see "Setting up for a final render" on page 429.

4 **Enter new values into the Row Subdivisions and Column Subdivisions fields.**
The greater the number of subdivisions, the smoother the mesh. A smooth surface produces higher resolution, but renders considerably slower than a rough surface. You can use a rougher surface for interactive rendering to speed up screen redraw and conserve memory while creating your scene.

5 **Click the Render Edges Sharper check box to make object corners render sharper.**
When this option is checked, Extreme 3D bases the rendering on the object's actual surface geometry rather than the approximation used for the polygon mesh. This gives objects with corners sharper edges. Leave this option off to speed up rendering time.



This object has Render Edges Sharper turned off.



This object has Render Edges Sharper turned on, so the shading is more defined at the object's edges.

6 **To preview the changes to selected objects, click Update.**
Extreme 3D renders the selected object(s) in the workspace with the new values. Final render settings also preview, even though the workspace is in interactive render mode. When you close the dialog box after previewing final render settings, the object(s) are redrawn with interactive values.

Tip: Use the Wireframe or Faceted Wireframe render style to preview the effect of different surface smoothness levels on objects.

7 **Click OK to save the settings and close the dialog box.**
If no objects are selected when you open the dialog box, no changes are saved when you click OK.

To assign uniform smoothing as the default smoothing type and set default values:

1 **Do not select an object in the workspace.**

2 **Follow steps 2–5 in the previous procedure.**

3 **Click Default to accept the changes and make the current values the default values.**
Only the default values are modified when you click Default—selected objects are not assigned the new default smoothness values.

Optimizing objects for rendering

Use the Display Polygon Faces command on the Render menu to turn off the rendering of back-facing polygons that won't be displayed in the scene. By optimizing the objects in the scene in this way, rendering time can be reduced.

When you create an object in Extreme 3D, Display Polygon Faces defaults to the most useful setting for that object type. For example, if an object appears as a solid, such as a cube, the polygon display defaults to Front Faces because all the back-facing polygons are assumed to be facing the inside of the cube and do not need to be shaded or rendered. Other objects default to Both, which means that both back-facing and front-facing polygons are displayed and rendered.

Usually, most of the objects in a scene can be set to Front to optimize rendering time. Sometimes you need to have both Front and Back polygons displayed.

- If you trim a hole in a solid object, back-facing polygons need to be displayed, otherwise it looks as if part of the object is missing.
- When an object has a transparent material, back-facing polygons are displayed in the final render, so set the polygon display to Both.

To optimize objects in the scene for rendering:

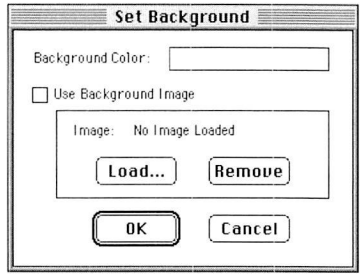
1. **Decide which objects should display only front polygons.**
   As discussed earlier, not all objects should display only front polygons.
2. **Select one or more objects in the workspace.**
3. **Choose Display Polygon Faces from the Render menu, then choose Front Faces.**

Adding a background color and image

You can add a background color or image, or both, to your scene. This adds color to the window and lets you render with an image in the background, such as a previously rendered image or an image created in another program. Background colors and pictures appear in all views of the scene. The background picture is placed in the upper left corner of the window and cannot be scaled or moved.

To add a background color, image, or both, to the scene:

1 **Choose Set Background from the Render menu.**
The Set Background dialog box appears.



2 **To set the background color, click the color swatch.**
The System Color Picker dialog box opens. Select a color and click OK. For more information on using this dialog box, see the instructions that came with your system software.

3 **Click Load to select a background image.**
A standard directory dialog box appears. Select an image and click OK. The following file formats can be used as background images: BMP, GIF, JPEG, PICT (Macintosh only), Photoshop 3.0, PNG, Targa, TIFF, and xRes LRG. This list includes the formats included with this version of Extreme 3D. Additional formats may be available after shipping, so the formats that you see may differ from this list.

When loaded, the background picture registers to the upper left corner of the workspace. The image is displayed at a constant scale, regardless of any scaling or camera motion in the scene. When you select an image, the Use Background Image check box is selected automatically. To speed up screen redraw while working on the scene, you can uncheck this box.

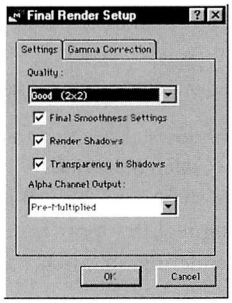
Note: For best results, background images should match the resolution of the final image.

Setting up for a final render

There are two ways to use the final renderer: Choose Final Render to Screen or do a final render to disk and select Final Renderer. Keep in mind that final render refers to using the final renderer, which you can also use to do test renders. The following options found in the Final Render Setup dialog box control how the final renderer calculates the image.

To set final render options:

1 **Choose Final Render Setup from the Render menu.**
The Render Setup dialog box appears.



2 **On the Settings page, select the level of quality you want from the Quality pop-up.**
This setting determines the amount of anti-aliasing that will be applied to each image. Anti-aliasing smooths out the edge stair-casing effect that occurs naturally when edges of objects are rendered as pixels. Shadows, texture maps, and dust (from dust cones) are also anti-aliased based on the Quality setting.

Rendering time increases as quality increases, so it's a good idea to keep the Quality setting lower when doing test renders. As the quality gets better, Extreme 3D breaks some pixels into subpixels and then calculates the sharpness of each pixel. An adaptive process is used to determine which pixels need to be divided, so the rendering time does not increase linearly. For example, Best (8x8) divides each pixel up to 64 times in order to get the crispest looking picture. The increase in rendering time is not proportional to the increase in quality (it doesn't take 64 times longer to render the scene with Best quality) but higher quality does result in a noticeable difference in rendering time.

3 **Select the Final Smoothness Settings check box to use the Final Render Settings for uniform and adaptive smoothing.**
Leave this check box unchecked to use the interactive smoothing values instead. Higher smoothness values take longer to render.

4 **Select the Render Shadows check box to render shadows with lights that have them.**
Spotlights and distant lights can have shadows, and spotlights can also have dust shadows. Shadows appear in the final render only if the Render Shadows check box is selected.

To add shadows to spotlights and distant lights, the Cast Shadows check box must be selected for each one. You can also have dust shadows with spotlight dust cones by selecting the Cast Dust Shadows check box in the Spotlight editor.

Tip: Turn off Render Shadows to speed up rendering for test renders or Final Render to Screen.

5 **Select the Transparency in Shadows check box to calculate shadows based on the amount of transparency in each material.**
When Transparency in shadows is on, each pixel is checked for transparency during rendering, so rendering requires more time. Turn this option off to speed up rendering for test rendering, or when transparent shadows are not needed.

6 **Select the type of alpha channel for the final rendered image from the Alpha Channel Output pop-up menu.**
This controls whether the alpha channel in the final image is Pre-Multiplied or Standard. Pre-Multiplied retains aliasing calculated for the image during rendering. Standard removes anti-aliased colors from the image.

7 **On the Gamma correction page, select the desired type of gamma correction, if any, that should be calculated for the final output.**
Gamma Correction optimizes the rendered image so that the colors look best when viewed in the intended delivery method, such as film, video, or print. For an explanation of Gamma Correction options, see the Final Render Setup topic in the Extreme 3D Help system.

Rendering to the screen

You can render the current window to screen with the Final Render to Screen command. As long as the current window is not set to the Fast Wireframe render style, the final renderer automatically uses the best possible shading, Phong shading, when rendering to screen, overriding object render styles and the window's Max Render Style.

The Fast Wireframe Max Render Style is a special type of internal interactive renderer that is designed for previewing animation in the workspace. When the current window's render style is set to Fast Wireframe (when using the internal interactive renderer only) the Render to Disk and Final Render to Screen commands are not available.

To render the current window to the screen:

- Choose Final Render to Screen from the Render menu. The current scene is rendered to screen. The Final Render Setup options (which control anti-aliasing, smoothness settings, and shadows) are used. Fog is rendered if it is turned on.

Rendering to disk

You can use either the final renderer or any of the interactive renderers to render the current window and save it to disk. Before rendering the completed scene to disk with all of the final settings, you may want to do several test renders so that you can check the movement in the animation without rendering all of the materials.

Note: If the current window's Max Render Style is Fast Wireframe, the Render to Disk command is dimmed. Fast Wireframe is a special type of interactive renderer that is designed for previewing animation in the workspace only.

This section describes the procedures for doing test and final renders, including:

- Using the interactive renderer to render a test scene
- Using the final renderer
- High-resolution rendering

Using the interactive renderer to render a test scene

There are many ways to do a test render in Extreme 3D. This section recommends one possible scenario and points out important issues.

Most of the options listed here are discussed earlier in this chapter. Before rendering the test scene to disk, be sure to check these settings, which affect interactive renders:

- Window Setup options
- Smoothness settings for each object

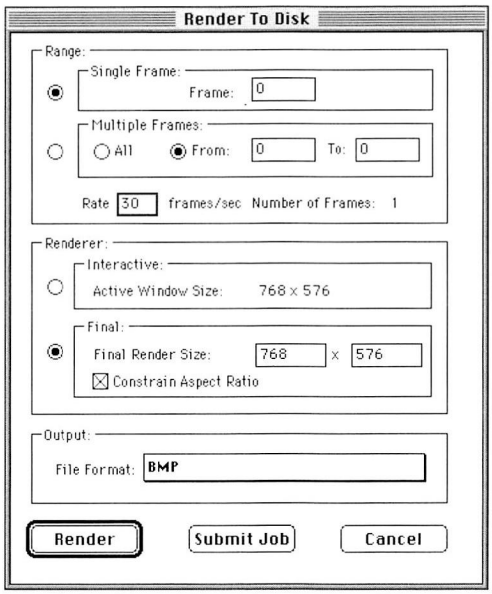
To perform a test render with the current interactive renderer:

1 **Select the window you want to render from and make it the currently active window.**
If you are testing animation, a window containing the camera view is typically used. To create a large image, you don't have to change the window size in the Window Setup dialog box; change the image size in the Render to Disk dialog box.

If you don't intend to render a large image, make sure that the window size is the desired render size. You can change the rendered image size in the Render to Disk dialog box, but any render size that differs from the current window size, even if it is smaller, means that the rendered image will follow the rules of high-resolution images, so all limitations of high-resolution rendering apply. For more information about rendering high-resolution images, see "High-resolution rendering" on page 438.

2 **Set the Max Render Style for the window in the Window Setup dialog box.**
You can choose any render style (except Fast Wireframe) for an interactive render to disk. To render motion but no colors or materials, use Wireframe. Individual objects that have a render style that is lower than the Max Render Style will appear in their own render style. (For example, if some objects are in Bounding Box and the Max Render Style is Wireframe, those objects will render to disk in Bounding Box, while objects in Hidden Wireframe will render to disk in Wireframe.)

3 **Choose Render to Disk from the Render menu.**
The Render to Disk dialog box appears.



4 **Select the range of frames to render.**
You can render any number of frames. When you select Single Frame, the name of the rendered image is the name you assign to it. When you select Multiple Frames, Extreme 3D uses a special naming format for file sequences. For most of the sequence file formats (BMP, JPEG, PNG, Targa, TIFF, and LRG) the file name is truncated to four characters, and the frame number and file extension are added to the name. For PICT files, the frame number is appended to the name you supply.

5 **Set the frame rate in the Rate field.**
Use a lower value than the frame rate set in the Preferences dialog box to do quick wireframe test renders. (This does not affect the score's frame rate.) The motion is less smooth than a higher frame rate and the timing is not accurate, but you can get an impression of the scene's motion and rendering time is faster.

6 **Select Interactive as the Renderer.**
The interactive renderer does not render alpha channel information from the scene, but alpha channel information from background images is included in 32- and 64-bit file formats. For more information on output file formats, see the Extreme 3D Help system. For more information about alpha channels, see "Creating effects with the alpha channel" in Chapter Five.

7 **Select the output format from the File Format pop-up.**
The following table shows the available file formats included with this version of Extreme 3D.

File format	Windows	Macintosh
AVI	✔	
BMP	✔	✔
GIF	✔	✔
GIF Animation	✔	✔
JPEG	✔	✔
PICT		✔
PNG	✔	✔
QuickTime		✔
Targa	✔	✔
TIFF	✔	✔
xRes LRG	✔	✔

Notes: Additional formats may be available after shipping, so the formats that you see may differ from this list. For more details on output file formats, see the Render to Disk topic in the Extreme 3D Help system.

You must have Video for Windows or QuickTime (Macintosh) installed and active in your system to render to one of these formats.

8 **Click Render to begin the test render.**
A standard directory dialog box appears so that you can choose a destination for the file. If you are rendering to AVI or QuickTime, a standard compression dialog box appears for that format. For more information on compression options, see the Render to Disk topic in the Extreme 3D Help system.

Note: You can also click Submit Job to use network rendering to complete this rendering task. Network rendering is discussed later in this chapter.

Using the final renderer

When using the final renderer to render the scene to disk, you can render the completed scene, a few frames, or even a single frame at high-resolution.

Before rendering the final scene to disk, be sure to check the following settings, all of which affect final renders. Most of these options are discussed earlier in this chapter. To learn about global effects, see "Creating fog" in Chapter Five.

- Window Setup
- Global Effects
- Smoothness settings for each object
- Final Render Setup

To render the scene with the final renderer:

1. **Select the window you want to render from to make it the currently active window.**
   For final renders this is usually a window containing the camera view. To create a large, high-resolution image, you don't have to change the window size in the Window Setup dialog box; change the image size in the Render to Disk dialog box.

   If you don't intend to render a large, high-resolution image, make sure that the window size is the desired render size. You can change the rendered image size in the Render to Disk dialog box, but any render size that differs from the current window size, even if it is smaller, means that the rendered image will follow the rules of high-resolution images, so all limitations of high-resolution rendering apply. For more information about rendering high-resolution images, see "High-resolution rendering" on page 438.

2. **Choose Render to Disk from the Render menu.**
   The Render to Disk dialog box appears.

3. **Select the range of frames to render.**
   You can render any number of frames. When you select Single Frame, the name of the rendered image is the name you assign to it. When you select Multiple Frames, Extreme 3D uses a special naming format for file sequences. For most of the sequence file formats (BMP, JPEG, PNG, Targa, TIFF, and LRG) the file name is truncated to four characters, and the frame number and file extension are added to the name. For PICT files (Macintosh only), the frame number is appended to the name you supply.

4. **Select Final as the Renderer.**
   The Final Render Size fields let you specify an output image size that is different than the current active window size. If you change the final render size, select the Constrain Aspect Ratio check box to constrain image proportions to those of the window you are rendering from. (Given a value for height or width, the other value is automatically computed when you press Tab.) Aspect ratio should be determined by the image size required by the final output medium (multimedia, video, or print).

   You can also render a single image up to 8K x 8K pixels. For more information, see "High-resolution rendering" on page 438.

5 **Select the output format from the File Format pop-up.**
The following table shows the available file formats included with this version of Extreme 3D.

File format	Windows	Macintosh
AVI	✔	
BMP	✔	✔
GIF	✔	✔
GIF Animation	✔	✔
JPEG	✔	✔
PICT		✔
PNG	✔	✔
QuickTime		✔
Targa	✔	✔
TIFF	✔	✔
xRes LRG	✔	✔

Notes: Additional formats may be available after shipping, so the formats that you see may differ from this list. For more details on output file formats, see the Render to Disk topic in the Extreme 3D Help system.

You must have Video for Windows or QuickTime (Macintosh) installed and active in your system to render to one of these formats.

6 **Click Render to begin the final render.**
A standard directory dialog box appears so that you can choose a destination for the file. If you are rendering to AVI or QuickTime, a standard compression dialog box appears for that format. For more information on compression options, see the Render to Disk topic in the Extreme 3D Help system.

Note: You can also click Submit Job to use network rendering to complete this rendering task. Network rendering is discussed later in this chapter.

High-resolution rendering

You can also use the final renderer to create large, high-quality, high-resolution images. You can render multiple frames of a sequence at one time, but when rendering very large frame sizes, the available memory in your system may limit how many images you can render in one session.

To render high-resolution images:

1 **Follow the steps in the previous section for doing a final render to disk, but with the following differences.**

2 **Enter the size of the image in the Final Render Size field.**
Any render size that differs from the current window size, even if it is smaller, means that the rendered image will follow the rules of high-resolution images, so all limitations of high-resolution rendering apply.

When changing the final render size, select the Constrain Aspect Ratio check box to constrain image proportions to those of the window from which you are rendering. (Given a value for height or width, the other value is automatically computed when you press Tab.)

3 **Select the output format from the File Format pop-up.**
You cannot render AVI or QuickTime as high-resolution images. The render button is not available if one of these formats is selected and the final render size has been changed. The following table shows high-resolution file format and size limitations.

File format	High-resolution format limitations	Maximum size (pixels)
AVI (Windows only)	Format not available	N/A
BMP	8-bit compressed option not available	8192 x 8192
GIF	None	8192 x 8192
GIF Animation	None	8192 x 8192
JPEG	None	8192 x 8192
PICT (Macintosh only)	None	4090 x 4090
PNG	None	8192 x 8192
QuickTime (Macintosh only)	Format not available	N/A
Targa	Compressed option not available	8192 x 8192
TIFF	None	8192 x 8192
xRes LRG	None	8192 x 8192

4 **Click Render to begin the final render.**
A standard directory dialog box appears so that you can choose a destination for the file.

Anti-aliasing for high-resolution images

Anti-aliasing, as set in the Quality pop-up in the Final Render Setup dialog box, is automatically limited for high-resolution image sizes to the quality settings listed in the following table.

Image size	Maximum Quality setting
8192 x 8192 pixels	Good (2 x 2)
4090 x 4090 pixels	Better (4 x 4)

Network rendering

Network rendering uses the processing power of multiple machines over a network to render animated scenes. In fact, with network rendering you can send rendering tasks to other computers on the network and continue to create scenes on your local computer.

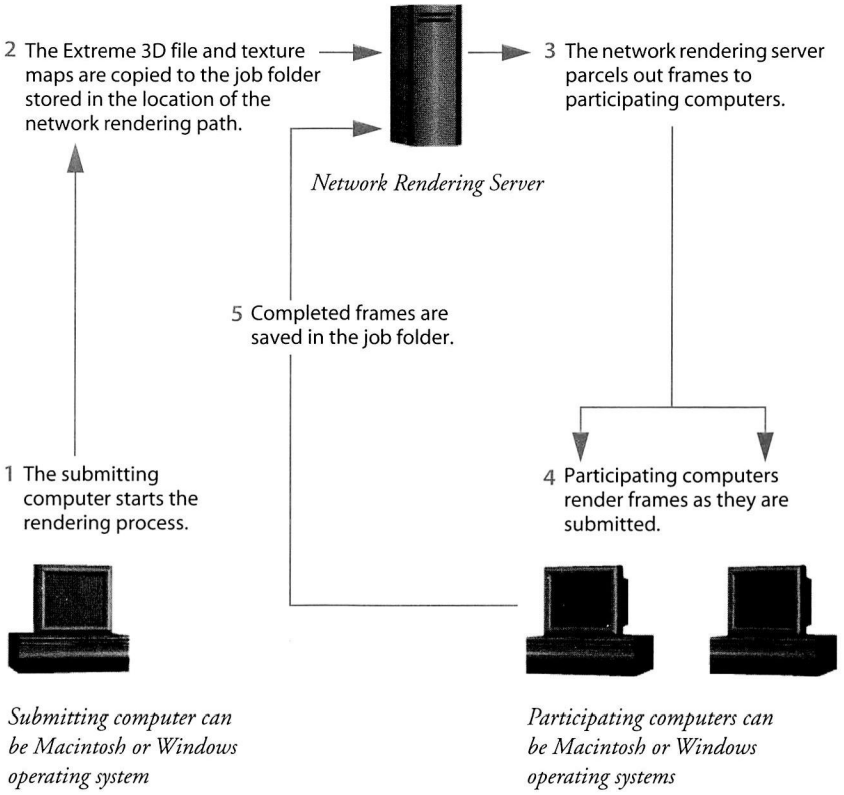
You can also use network rendering to submit multiple rendering jobs on one computer—you can submit a group of scenes and render them one after the other. While this does not speed up rendering, it does enable you to submit multiple rendering jobs at once to a single computer. You can even save up rendering tasks and let them run overnight or while you are away from your computer for a period of time.

The following sections explain network rendering in detail:

- **Network rendering concepts**—explains the basic concepts behind network rendering and describes the roles played by the various computers involved.
- **Rendering across a network**—provides a detailed procedure for starting the network rendering process.

Network rendering concepts

Network rendering speeds up the rendering process by using multiple computers to render frames from one scene simultaneously. (Network rendering cannot speed up the time required to render a single image.) This is how it works: one computer manages rendering tasks for multiple computers connected to a network. (This computer is usually a network server, although it is not required to be.) Any machine that submits a rendering task provides the necessary files to the network server, which then finds one or more participating computers (which are in network rendering mode) to render frames for the current job. The network server then stores that frame in a pre-designated location after rendering is completed. A computer in network rendering mode processes any tasks that the network server gives it.



Note: A network is not required to make use of network rendering. If a directory on your machine is specified in Preferences, Enable Network Rendering Mode will initiate a batch rendering process and render any submitted images to the specified directory.

To participate on a job through network rendering, each computer that participates must have a copy of Extreme 3D installed locally and each computer must point to the same Network Rendering Path as the network server and the computer that is submitting the job. The Network Rendering Path tells each machine where to store each frame after it has been rendered. Set the network rendering path on the Network page of the Preferences dialog box.

Network rendering requirements and roles

Read the following sections to learn about the specific requirements and roles of each computer that participates in network rendering.

The network rendering server does the following:

- Takes all of the files required for rendering a scene from the submitting computer. Files that are needed for rendering are copied to the server (to the location specified by the network rendering path). Extreme 3D does not need to be installed on the network rendering server.
- Transfers data, as required, to and from computers on the network that are participating in the rendering task.
- Stores the rendered images.
- After this point, any system can participate on completing this network rendering task.

Any computer that submits network rendering tasks must meet these requirements:

- Extreme 3D must be installed and running.
- The network rendering path must point to the same location on the network server that all of the participating systems point to. This computer must also have read/write access to this network server location.
- The Extreme 3D files to be rendered must be accessible from this system (they can be stored locally or on a network drive).
- The submitting computer can be a Windows or Macintosh computer. Network rendering works the same on both platforms. Both Windows and Macintosh systems will automatically participate in rendering tasks for cross-platform file formats. (For interactive cross-platform network rendering, use the internal renderer on all participating computers for best results.)
- Once the network rendering job is submitted, this computer is not required to participate in the rendering tasks. Other systems can complete the rendering. To have this system participate, treat it as any other computer assisting in network rendering (by enabling network rendering mode).

Any computer that participates in network rendering tasks must meet these requirements:

- Extreme 3D must be installed and running.
- The network rendering path must point to the same location as the path specified on the submitting computer. All participating computers must have read/write access to this network server location.
- Network Rendering Mode must be enabled. (Choose Enable Network Rendering Mode from the Render menu after setting Preferences.) The Network Rendering Server Mode dialog box appears and displays status information.
- This system participates on network rendering whenever it can, that is, it renders when the file format is compatible to this operating system. (For example, if the file format is PICT, the Windows machine will not process this job.)
- For interactive cross-platform network rendering, use the internal renderer on all participating computers for best results.

Tip: If you have two computers that are connected by a network, keep the second one in network rendering mode at all times. Then you can submit rendering tasks as you go. The scenes will be rendered on the second computer, allowing you to continue working on scenes without interruption.

Rendering across a network

You can use network rendering to render scenes in most of the file formats that Extreme 3D supports, and most of these formats are cross-platform, which means that both Windows and Macintosh computers can participate in network rendering, regardless of the type of machine that submits the job.

The following table lists Extreme 3D's file formats and shows which can be used in network rendering and cross-platform network rendering. For more information about output file formats, see the Extreme 3D Help system.

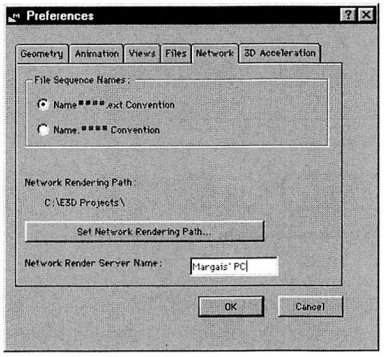
File format	Network rendering capable?	Cross-platform capable?
AVI (Windows only)		N/A
BMP	✔	✔
GIF	✔	✔
GIF Animation	✔	✔
PICT (Macintosh only)	✔	No. Only Macintosh computers can assist in rendering.
JPEG	✔	✔
PNG	✔	✔
QuickTime (Macintosh only)		N/A
Targa	✔	✔
TIFF	✔	✔
xRes LRG	✔	✔

To render a scene using network rendering:

1 **Prepare the scene for rendering as described earlier in this chapter.**

2 **Set the Network Rendering Path and the Network Render Server Name in the Network page of the Preferences dialog box.**
The network rendering path is the location that the rendered file will be saved. If rendering over a network, select a path on a network drive that all participating computers can write to. You can select a local hard disk for the path if you are rendering on only one machine.

The Network Render Server Name is optional. It designates the name of the server and is useful for keeping track of the systems that are being used.



3 **Specify the preference for file Sequence Names for rendered sequences in the Network Page of the Preferences dialog box.**
This preference determines how a sequence of rendered images (for network rendering only) will use the given file name and add the sequence numbers to it—using either the Windows or Macintosh style. Since rendering tasks can be submitted from either type of computer, this preference lets you name the files so that they are accessed easily from the type of computer for which they are intended.

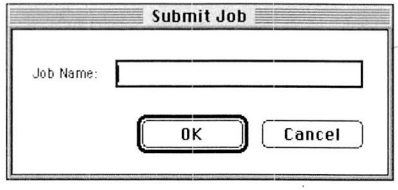
Where #### represents the sequence numbers:

- Select **Name####.ext** to use the standard Windows file sequence naming convention. In this naming style, the provided file name is truncated to four characters and the frame number and file extension are added to the name.
- Select **Name.####** to use the standard Macintosh file sequence naming convention. In this naming style, the frame number is appended to the name you supply.

The network rendering naming convention is controlled by the preference setting of the computer that submits the rendering job. The preference setting of the computer that assists in network rendering has no affect on the naming convention.

4 **Open the Render to Disk dialog box and select the rendering options for the scene.**
You can do network rendering on Macintosh and Windows machines simultaneously if you select any of the cross-platform file formats.

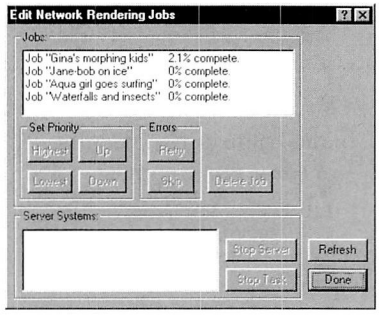
5 **Click Submit Job.**
The Submit Job dialog box appears so that you can name the job. If you use a name that already exists, you are prompted to replace the existing file with the new file, cancel the job, or give the new file a different name.



6 **Enter the name of the job and click OK.**
The job is added to the list of jobs in the Edit Network Rendering Jobs dialog box.

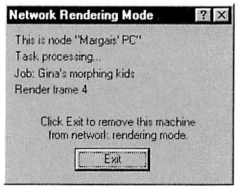
7 **You can open other scenes and repeat steps 3-6 to add additional jobs to the list.**

8 **To view the status of submitted jobs, choose Edit Network Rendering Jobs from the Render menu.**
In this dialog box you can also delete, skip, and change the rendering priority of submitted jobs, and view each job's completion status.



9 **To start rendering the first job on the list, choose Enable Network Rendering Mode from the Render menu.**
All open scenes are closed and Extreme 3D begins rendering the first job. You can put a computer into network rendering mode at any time—before, after, or during network rendering.

A status box appears on the screen of any computer that is participating in network rendering. It displays the server name, job name, and the current frame that is being processed. It displays Idle when waiting for another job or when all jobs are completed.



10 **To add other computers on the network to the network rendering process, start Extreme 3D, add the Network Rendering Path and Network Render Server Name to the Preferences dialog box, and choose Enable Network Rendering Mode from the Render menu.**
Extreme 3D parcels out frames from the current job to each computer involved in network rendering.

11 **Click Exit to take any computer out of network rendering mode.**
That task is then redistributed to other participating computers. You can also press F-11 (Windows) or Escape (Macintosh) to exit network rendering. If only one computer is participating, rendering stops, but the job stays in the Edit Network Rendering Jobs dialog box and can be restarted at a later time.

G Glossary

absolute value: A value or change in a value of a property that is made with respect to the original value.

adaptive smoothing: Smoothing that is applied where needed, rather than uniformly.

alpha channel: The piece of information about a pixel that describes its transparency, relative to the other pixels. This is used in compositing images together; it is distinct from object transparency.

ambient light: A light that saturates a whole scene. It simulates the light that suffuses a scene after reflecting off of many objects.

angle of view: The angle between opposite faces of the viewing pyramid. The viewing pyramid is created at the center of the view by two lines that are drawn from the view center to the bounds of the view. The angle of view is larger for a more extreme perspective.

animation controls: The Extreme 3D window that contains the VCR-like controls used to change the current time and playback an animation.

animation value: The value of a keyframe that represents the change in the object's property. The animation value of each keyframe, in combination with its time values and the motion style applied to keyframe ranges, determines how the animation for a property is interpolated.

anti-aliasing: Removes jaggies, the stair-casing effect that occurs when object edges are rendered as pixels. It does so by blending the object's color with what is behind it. Anti-aliasing also refers to filtering texture maps to prevent distracting moiré patterns.

aspect ratio: The ratio of height to width of an image.

back-facing polygons: Those polygons whose normals point away from the viewer or camera.

ball-joint link: A link in which the child can rotate around its center point and be scaled independently of its parent, but cannot move independently of its parent.

bevel: An angled or shaped cut, such as the kind found on the edge of a mirror or a piece of molding. Use the Bevel Extrude tool to create beveled objects from profiles.

Bézier curve: The type of spline used in Extreme 3D.

bitmap: A 2D raster image that is composed of pixels.

booleans: Refers to the joining or removing of one shape from another. *See also* trim curve.

browser: One of several windows in Extreme 3D that organizes scene elements. There is a browser associated with each type of scene element (***Objects browser***, ***Views browser***, ***Lights browser***, and ***Materials browser***). The Lights and Materials browsers each have editors associated with them that allow you to edit the properties of the scene elements they contain (***Light editor*** and ***Material editor).***

bump map: A bitmap image file that is used to modify surface normals. When applied like a texture map to a surface, the values in the image are treated like a height field. The normal is perturbed accordingly, creating the illusion of bumps on the surface. The color of the map is not applied to the surface.

Cartesian coordinate system: A geometry system in which numbers are used to locate a point on a plane in relation to an origin where one or more lines intersect.

center point: The point of an object around which the object rotates. The center point of all objects can be moved. The location of an object's center point determines how it will be linked or aligned, and how its surface control points will move when edited.

champfer: *See* bevel.

child object: The subordinate object in a linked object hierarchy. By default, all objects are children of the world, so their positions and orientations are relative to the world's coordinate system until they are linked to another object. When linked, the child's position and orientation is relative to its parent.

clipping plane: A plane beyond which an object is not visible. A view of the world has six clipping planes: top, bottom, left, right, hither, and yon.

codec: A technique for compressing and decompressing a sequence of images (such as QuickTime or AVI movies) so they take up less space but can be displayed without a loss of information when they are reopened. *See also* compression.

color: A property of lights and materials. Materials can be comprised of several colors. Color is represented as a combination of three values: red, green, and blue.

compound profile: A profile that is created by modifying or combining other profiles or parts of profiles.

compression: One of several techniques for storing images so they take up less space. These techniques can be based on color comparisons, difference comparisons, or hardware requirements. *See also* codec.

construction objects: A set of reference objects—grids, axes, points, and lines—to which you can snap or align the components of your model. Construction objects do not appear in a final render.

cross-section: A means of creating a surface from two profiles by stretching one profile (the cross-section) along the shape of the second profile (the face).

cubic mapping: A method of placing a texture map on an object such that the map is replicated six times. When cubic mapping is applied to a cube, each face is covered by one copy of the map.

current time field: The fields at the top of the both the animation controls and the score that show and set the current animation time.

cycle: The repetition of a segment of animation used to create repetitive motions like pistons pumping, birds flying, and flags waving.

cylindrical mapping: A method of placing a texture map on an object such that the map is wrapped into a cylindrical shape around the object and then shrink-wrapped onto it. For example, cylindrical mapping can be used to place a label on a bottle.

default materials: The set of material prototypes in Extreme 3D that are used to generate a number of custom materials by editing their basic properties. Extreme 3D has eight default materials.

default tool: The tool that automatically becomes the selected tool when you finish using any other tool.When you first launch Extreme 3D the arrow tool is the default tool. If you use a tool different from the arrow tool repeatedly, you might want to make it the default tool by selecting it while pressing the F4 key (Windows) or Option key (Macintosh).

defining geometry: The profiles and tool settings from which a surface was created. Extreme 3D lets you edit defining geometry even after the surface has been created.

deformation animation: A method of animating changes to the shape of an object by using the free-form deformation tools.

delta change: The values of an object's position or orientation that represent the amount the value has changed from its previous value. If you know how much you want a value to change, use Delta to View and enter the known value into the position or orientation field.

distant light: A light in the Extreme 3D scene that exists at a point infinitely far away and whose effect does not diminish over distance. Distant lights have orientation but not position values.

dithering: A way of using many pixels of different colors to create the appearance of a color in-between those of the pixels.

dolly: A camera motion made with a film or video camera by moving the camera in a smooth gliding motion along the sight of the camera. With film and video cameras this move is usually performed with the aid of a wheeled vehicle called a dolly.

down tree: All those objects that are children to an object.

dynamic display area: The fields at the top of the score that display the keyframe values for the currently selected track at the current time.

easing: Controls the way animation is interpolated between keyframes. Easing in gradually accelerates the animation from zero velocity; easing out gradually decelerates the animation to zero velocity.

end cap: A special piece of geometry created by the lathe, sweep, and extrude operations and linked to the object to close their otherwise open ends.

end time: The field on the animation controls where you set the end point of the animation playback.

environment map: An image file that provides an environment for reflective surfaces to reflect. This allows the user to "fake" reflections of a scene surrounding an object.

establishing shot: The initial view that usually encompasses the entire scene from which camera animation is begun. It is common in traditional film and video work to use establishing shots.

extrude: Creates a surface by extending a profile into space along a specified line. In a real-world example of this process, wood, metal, or clay are forced through a die of a certain shape. Water system conduits and pasta are made by extruding.

eye point: The location of the viewer relative to the Extreme 3D world. Views and the camera have an eye point.

fall off: The distance at which a light is at half intensity. In the real world, intensity falls off with respect to the distance of a light. In Extreme 3D you control the fall off through this value.

final renderer: The high-quality renderer that can calculate all materials and effects. It takes longer to render with the final renderer. The time difference varies greatly depending on how complicated the scene is, the effects used, and which rendering options are selected.

flipping: A method of placing a texture map on an object that mirrors the texture map across the axis you specify.

fog: A lighting effect that simulates the effect of fog or haze. In Extreme 3D, use Global Effects to add fog to the scene.

frame: One of the many individual images contained in an animation.

frames per second: A preference that controls the number of frames that will be generated for each second of animation.

free-form deformation: A technique for deforming the shape of objects. To use the free-form deformation tools, objects must be simplified. Extreme 3D has five different free-form deformation tools—stretch, twist, bend, taper and skew.

free link: A link in which the child object can move independently of its parent, but moves when the parent moves. The child changes scale, orientation, and position in response to corresponding changes in the parent's scale, orientation, and position.

fresnel factor: An optical effect that makes objects look more optically realistic. When brighten edges is selected in one of the smoothing dialog boxes, the reflection intensity increases at the object edges. That is, the edges are brighter and the same color as the light.

front-facing polygons: Those polygons whose normals point towards the viewer or camera.

gimbel lock: A situation in which an object loses the freedom to rotate around one or more of its axes. Extreme 3D's use of quaternions to calculate rotations prevents gimbel lock.

Gouraud shading: A shading calculation that computes shading only at polygon vertices and averages that color information across polygon faces to create a smooth rendered look and a fairly accurate idea of the effect of lights. The Smooth render style uses Gouraud shading for interactive and final renders. The Shader render style use Gouraud shading for interactive renders.

grid scale: That part of the world to grid scale ratio that represents the size an object would be in the real world.

ground plane: A grid that is located at the center of the Extreme 3D world. It is oriented to the x-z plane to create a reference for the ground.

heads-up orientation axis: The axis that appears in the lower left corner of the workspace. It indicates the orientation of the view with respect to the world's coordinate system. The positive directions of each of the world's coordinates are represented by their letter names: x, y, and z.

hierarchy: The relationship of all the objects in Extreme 3D world to each other and to the world itself. The World browser and the score present a schematic way of looking at the Extreme 3D hierarchy.

hither plane: *See* clipping plane.

hit radius: An area four pixels in diameter around the cursor in which Extreme 3D searches for objects to snap to.

hot key area: The space at the left end of the tool space that provides feedback about the current snap-to-grid setting.

hue: The particular shade or tint of a color.

intensity: The brightness of a light.

interactive renderer: Creates an approximate render of the scene. It works much more quickly than the final renderer. With this renderer, you can see shapes and colors, but some of the scene's details, like shadows and fog, are not rendered.

interpolate: The calculation done by the computer to estimate the unknown values that fall between two known values. The animation values between two keyframes are interpolations done by the computer.

intrinsic mapping: A means of placing a texture map on a surface using the object's own geometry as a guide to placement. Other placement techniques, such as spherical and cylindrical, assume the geometry of a sphere or a cylinder to guide the placement.

keyframe: The animation information that a property has at a specific time. Keyframes are indicated in the score as small rectangles distributed across the property's track. Keyframes are automatically created when you change values at any time other than time zero.

layer: A means of organizing objects in the Extreme 3D world so that they can be hidden and shown in related groups.

lathe: A means of creating a surface by rotating a profile around an axis. In the real world, wood or metal are turned on lathes against different shaped carving tools to create table legs and stair rails. In Extreme 3D the profile can be thought of as the carving tool which carves a surface.

Lights browser: The window in Extreme 3D used for creating, organizing, and manipulating lights.

Light editor: Displays the properties for the default lights and lets you edit the properties of lights as you customize them.

light objects: The objects in the workspace that represent omni lights and spotlights in the Extreme 3D world.

light switch: The property of a light that allows you to toggle the light's effect off and on. The default state for all lights is on.

line: The length that extends between two points. Use the line tool to draw a straight line in the workspace.

linear motion style: Calculates the unknown frame values between two known keyframe values or an animation track by figuring out the shortest distance between the two values.

linking: A technique for creating object hierarchies. When you link one object to another object, the second object becomes subordinate to the first object. The first object is called the parent object and the second object is called the child object. The child object's position and orientation are relative to its parent rather than to the world. Parents can have any number of children, which in turn can have their own children. A child, however, can only have a single parent.

local lights: The generic term for omni light and spotlight objects.

lock link: A link in which the child object is bound to its parent, changing scale, orientation, and position in response to corresponding changes in the parent's scale, orientation, and position. Neither the parent nor the child object can move, rotate, or be scaled independently of each other.

look-at point: The center of the view, that is, the point in the world at which the view converges. Views and the camera have a look-at point.

luminosity: The brightness or value of a color. It also refers to the total amount of light emitted by an object.

Materials browser: The main window in Extreme 3D for creating, organizing, and manipulating materials.

Material editor: Displays the properties of the default materials and lets you edit the properties of materials as you customize them.

Mercator map: A 2-dimensional map in which meridians are straight lines at right angles to the equator. A Mercator map of the world distorts the north and south poles, but when mapped to a sphere or reflection mapped these features appear to be correct.

menu bar: Contains editing, viewing, object manipulation, animation, rendering, and file and window management commands.

metaforms: blobs created from defining profiles. The blobs have an attraction for one another that allow them to flow together and break apart when you move their defining profiles. This quality makes modeling with metaforms similar to modeling with clay. Create metaforms with the metaforms tool.

model: An object hierarchy that is created by orienting and aligning surfaces with one another and linking them together.

moiré pattern: A watery, wavy pattern that occurs when the stripes in striped patterns are close together and become aliased.

negative lights: Lights with intensity values less than 0.

network rendering: The process of rendering one or more files on a single machine or over a network. With network rendering you can simultaneously render different frames of a single scene by using the processing power of several machines on a network.

noise function: A mathematical calculation that uses randomness to generate a color pattern. This improves photorealism in 3D scenes.

normal: The direction that is perpendicular to a polygon's surface that is used by Extreme 3D to perform shading and smoothing calculations. Normals are not displayed and cannot be directly manipulated in Extreme 3D. However, the Display Polygons and Reverse Ordering commands, and the Render Edges Sharper option in the Uniform and Adaptive smoothing dialog boxes use surface normals to calculate shading when objects are rendered.

nudge: To move, scale, and rotate objects in very small increments in the workspace using the arrow keys. Set nudge increments in the Preferences dialog box.

object: Any reference guide, profile, surface, or model that can be moved, scaled, or rotated in the Extreme 3D workspace.

object axis: The axis that appears at the center of all objects when the Display Object Axis preference is selected. This axis indicates the orientation of the object in the 3D world's coordinate system.

Objects browser: The window in Extreme 3D used for naming, moving, reorienting, and manipulating 3D objects and profiles.

objects filter: A filter field in the score that allows you to choose the type of objects to be displayed in the score list and for which you want animation information displayed.

objects of rotation: Objects created with the lathe tool. They are inherently circular, although they may be lathed through only a portion of the circle. Also called surface of rotation.

offset an animation: To move the beginning and ending times of an animation.

omni light: A light that has a position in the 3D world and is represented as an object within the 3D scene. It shines in all directions (360 degrees).

orthographic perspective: A viewing perspective that uses an infinite viewing distance. With an orthographic view there is no distortion of objects. Objects are lined up in the order they recede from the viewer and object size is displayed as if each object were the same distance from the viewer.

pan: A camera move accomplished by rotating the camera side-to-side about its vertical (y) axis.

parent-child relationship: The hierarchical relationship of linked objects that comprise a model.

parent object: An object that has one or more objects subordinate to it in a linked hierarchy.

parent relative: Each object in the world and the world itself exists within a coordinate system. The world's coordinate system is always indicated by the heads-up orientation axis. The coordinate system of each object is indicated by the object's axis. When you enter values for an object's position and orientation properties in the Objects browser and parent relative is chosen, the object moves relative the its parent's coordinate system.

particle system: A collection of shapes or polygons that evolve over time, typically used to simulate dynamic phenomena such as smoke, water, or fire. You can also use particle systems to model complex collections of shapes such as dandelion seeds or trees. Create particle systems with the particle systems tool.

paste-replace: Pastes and replaces an object to the position and orientation of a selected object.

perspective: A way of viewing objects in 3D space that distorts them according to their view distance from the eye point of the view to duplicate the perspective of the real world. The shorter the view distance, the wider the perspective and the more distorted the object appears; the greater the view distance, the narrower the perspective.

Phong shading: A rendering algorithm that computes shading at every pixel, creating higher quality surfaces than ***Gouraud shading***. Phong shading takes more time to render. Extreme 3D uses Phong final renders.

pitch: Rotation around an x-axis.

pixel: One of the small dots (picture elements) that make up a computer image.

playback controls: The buttons on the animation controls that work like standard VCR controls: play, stop, rewind, fast forward, step backward, step forward.

playback head: The marker in the score that can be dragged along the timeline to set the current time. The playback head updates automatically to the current frame when the current time is changed.

playback modes: The three settings on the animation controls that determine how the animation plays back. The normal setting plays the animation once from the start time to the end time; loop plays the animation repeatedly from the start time to the end time until you choose to stop; reverse playback plays the animation forward (from the start time to the end time), then plays it in reverse (from the end time to the start time) continuously.

polygon: A portion of a surface defined by straight edges. In Extreme 3D, polygons are the smallest unit of geometry and assumed to be flat or planar surfaces. Surfaces can be reduced to polygons by simplifying them twice. The process of reducing surfaces to polygons is sometimes called tessellating, or faceting the surface. For purposes of rendering control, any surface in Extreme 3D can be displayed or rendered as polygons without simplifying the surface by using the render styles available on the Object menu. Extreme 3D converts all surfaces to polygons in order to render them.

polygon normal: *See* normal.

polygon resolution: The number of polygons that are drawn to represent an object's surface, as seen when you choose the wireframe render style.

polylist: A collection of polygons that describe a surface. A surface with a hole that is twice simplified results in a polylist. The polygons of polylist surfaces can have any number of sides. The vertices of adjacent polylist polygons are not necessarily shared.

polyline: A line that has more than two points and defines a sequence of straight lines.

polymesh: A rectangular array of vertices that describe a surface. Most surfaces that are twice simplified result in a polymesh. The polygons of a polymesh surface are created by connecting vertices in a prescribed rectangular pattern. The vertices of adjacent polymesh polygons are always shared.

preset views: A set of views available in the View menu that allow you to quickly change your view of the workspace and Extreme 3D world. These views enable you to see a model or a scene from several preset angles, including front, top, and right.

preview FPS: The field on the animation controls where you set a temporary frames-per-second rate for previewing animation sequences in the workspace.

profile: The fundamental defining geometry of any Extreme 3D object. Typically, models in Extreme 3D are created by drawing profiles using the line, polyline, spline, rectangle, square, polygon, circle, ellipse, arc, or tangent arc tools. Extreme 3D's geometry tools—extrude, lathe, sweep, or skin—can then be used to turn one or more profiles into a surface.

projection tool: A tool that projects the shape of a profile onto a surface for the purpose of trimming the surface.

projective mapping: A method of placing a texture map on an object such that the texture is projected through the object's surface in much the same way that a photo transparency is projected through a movie screen or curtain.

property: An attribute of an object that can be animated. Position, color, and visibility are all examples of object properties.

quaternion: A set of four values used by Extreme 3D to describe an object's axis and its rotation relative to that axis. Use of quaternions avoids gimbel lock.

RGB: An acronym that stands for red, green, blue. It is the combination of red, green, and blue color values that create a given color. Each pixel has its own RGB value.

reflection: Light that is thrown back from the surface of an object.

refraction: Light that is bent as it passes through one medium (air for example) into another medium of a different density (glass for example).

render: Creating a two-dimensional picture or series of pictures from the three-dimensional geometry, lights, and materials information contained in a scene file.

roll: Rotation of an object or camera around the z-axis.

roughness: One of the material attributes that affects the specular reflections from an object. In the real world this quality is the determined by the physical roughness of a surface. The finish of a paint, for example, is determined by the height of particles left suspended on the paint. Paints that have high gloss finish contain fewer bumps than paints that have a flat finish. The roughness attribute lets you have the same kind of control in 3D shading calculations. Extreme 3D uses a color for roughness that allows independent control of the red, green, and blue roughness values.

roughness map: A texture map that is used instead of a roughness color to control highlights. Roughness maps are often used with specular maps to achieve this effect.

saturation: The degree of intensity of a color. A color that has less gray in it is more highly saturated.

scale: Makes an object proportionately smaller or larger in all three dimensions.

scale an animation: Lengthen or shorten an animation.

scanline renderer: Extreme 3D uses a scanline renderer for final renders. All 3D renderers need to solve the same problem: What happens when two pixels are in the same place, such as when one object is in front of another? Scanline renderers solve this problem by keeping track of the geometry of all objects in the scene and sorting objects by their distance from the camera at render time.

scene: An Extreme 3D world that you have customized by adding models, lights, materials and/or animation to, and saved in an E3D file.

score: The Extreme 3D window that contains all the time information about each object and property in the scene.

shader: See default materials.

shading: The coloration of a surface that results from the light striking the surface at an angle.

shadows: A property of distant lights and spotlights that accurately renders shadows cast by one object onto the surface of another object.

simplifying geometry: The process of providing access to all the surfaces, splines, polygons, and vertices of the geometry that make up an object. When a 3D object is simplified in Extreme 3D, the geometry is accessible first as a surface. Each successive simplification removes a level of geometry until the geometry is represented as a set of polygons.

skin: Stretches a surface over a series of profile ribs. A canoe or an airplane wing are examples of objects that can be built by skinning.

smooth motion style: Calculates the unknown frame values between two known keyframe values or an animation track by interpolating the distance as a curve rather than as a straight line.

smoothing: A technique that allows you to interactively change the polygon resolution of a surface and set the polygon resolution for the final render. Extreme 3D supports two kinds of smoothing. ***Adaptive smoothing*** interprets the surface of a model as polygons that are concentrated more in areas where the surface bends or changes direction rather than in broad or flat expanses of surface. ***Uniform smoothing*** converts the surface of a model into a gridwork of evenly spaced polygons.

specular: The direct reflection of light off of a surface. The specular color determines the color of the specular highlight of a material.

specular map: A texture map used instead of a specular color to control highlights. Often specular maps are used with roughness maps to achieve this effect. Typical specular maps include images that are created with noise filters and images composed of cross-hatches or scratches.

spherical mapping: A method of placing a texture map on an object style that wraps the map like a cylinder around a sphere and then pinches the top and bottom of the image into poles, reducing the top and bottom into one point. Then the image is shrink-wrapped onto the object. By using a Mercator map of the world and using spherical mapping on a sphere you can create a globe of the world. *See also* Mercator map.

spline: A curve that is defined by three or more control points. The angle of the curve at each control point can be controlled by adjusting the control point's tangent lines. Extreme 3D is a spline-based modeler, which means that all surfaces consist of a matrix of spline curves instead of a matrix of polygons. This gives you the ability to edit and animate surfaces as spline curves.

spotlight: A light that is represented as an object within the Extreme 3D scene whose beam is emitted as a cone of light that can be specified to be brighter in the middle than at the edge. Spotlights can have both positions and orientations.

start time: The field on the animation controls where you set the beginning point of the animation playback.

status bar: A help bar at the bottom of the Extreme 3D screen that gives you information about using Extreme 3D tools, menu items, and controls. When the cursor is over a tool in the tool palette, the status bar displays the name of the tool. When a tool is selected and the cursor is in the workspace, the status bar tells you how to use the tool. If there are several steps involved in using a tool, the status bar displays each step in succession—when you complete one step, the next is displayed.

substitution animation: A method of animating seemingly instant changes in which one object is substituted for another object at a specific frame.

surface: A matrix of spline-based control points and tangent line end points created by applying one of Extreme 3D's geometry tools to a profile.

surface color: Sets the base color of the object.

surface objects: Three-dimensional objects built from one or more profiles using one of the 3D geometry tools.

surface geometry: The geometry that is exposed when a surface object has been simplified once. At this level the object appears as a matrix of spline-based control points.

sweep: Creates a surface by pulling a profile along a specified path. Sweeping is similar to extrusion, except that sweeping allows you to create more complex shapes that twist and bend because the profile can be swept along a curve instead of being restricted to a line. Sweeping does not have a real-world parallel, however an object like a faucet can be thought of as a swept object.

tangent line: A line that passes through the control point of a spline and is tangent to the curve. The tangent line can be used to adjust the angle of the curve.

texture map: A picture that is applied to a surface by relating the internal coordinates of the picture (sometimes called u-v coordinates) to the object coordinates of the surface. Specular and bump maps are special kinds of texture maps.

tiling: A method of placing a texture map on an object that replicates the texture map across the surface of the object. The number of times the map is tiled is determined by the map's scale. You specify the scale when you place the map with one of the texture map placement tools.

tilt: A camera move that is performed by rotating the camera up and down about its horizontal (x) axis. Tilts are usually less than 180 degrees. They are sometimes called vertical pans.

timeline: The graduated scale along the top of the score that displays the time continuum of an animation as calculated by the frames-per-second value set in the Preferences dialog box.

time mode: A preference that determines how time is displayed in the current time field of the animation controls and the score.

time scale: The filter field in the score that allows you to set the granularity of the score's display of keyframes.

time value: The keyframe value that represents the moment in the animation in which a change takes place. The time value for each keyframe, in combination with its animation values and the motion style applied to keyframe ranges, determines how the animation for a property is interpolated.

time zero: The point at which animation begins in the Extreme 3D score. You can go to time zero by setting the current frame field or moving the playback head in the score to 0.

tool palette: The window that contains tools for creating, modeling, editing, and manipulating profiles and surfaces.

tool space: Displays numerical text and measurement information. When creating profiles and surfaces, you can edit these values.

track: Stores all the animation information that belongs to a single property for the length of the animation.

trackball: The cube in the browsers that represents the orientation of the current view or object.

track filter: A filter field in the score that allows you to choose the properties whose names you want displayed in the score list and for which you want animation information displayed.

tracking shot: A camera move that involves moving the camera in a smooth gliding motion past the subject on a plane parallel to it. Sometimes this is called a trucking shot.

trucking shot: See tracking shot.

translucent: A substance that lets light through but diffuses it so that objects cannot be clearly seen on the other side of it, such as frosted glass.

transparency: Determines how much an object's surface occludes those objects behind it. In Extreme 3D, this value directly manipulates the alpha channel.

trim curve: A curve drawn on an object's surface after a profile has been projected onto the surface or another object has been intersected with it. The trim curve allows you trim away parts of the surface.

uniform smoothing: Smoothing that is applied uniformly on the object's surface.

up vector: A line perpendicular to the eye point of the camera that allows the camera object to be rolled around the eye point. The up vector also keeps the camera from turning upside down when it is watch linked to another object. Any object that is watch linked has an implied up vector.

u-v coordinates: A rectangular 2D coordinate system imposed on a surface for the purpose of matching a texture map to a three-dimensional surface.

value: The brightness of a color in a Hue, Saturation, Value color system.

velocity: The rate of change in an object's position relative to time.

vertex: The x, y, and z location of each corner of a polygon or control point.

vertex animation: A method of animating changes to the shape of an object by animating its surface control points directly in the workspace.

vertex normals: See normals.

view: A means of changing your position relative to the world. Views can be thought of as the directions you give to the computer to fly you through the world in order to look at objects in it.

view angle: See angle of view.

view relative: In view space, the positive x-axis always points to the right of the screen and the y-axis always points up. When you enter values for an object's position and orientation properties in the Objects browser and select view relative, the object moves relative the view's coordinate system. For example, entering a value of one in the X field moves the object one unit to the right.

Views browser: The window in Extreme 3D used for creating, organizing, and manipulating views.

view distance: The distance between the eye point and the look-at point of the camera or a view.

view distance line: The part of the camera object that represents the camera's view distance. It is indicated by a line between the eye point and look-at point.

view distance vector: The control point on the camera that adjusts the camera's view distance line and its perspective.

watch link: A linking technique in which the z-axis of an object stays oriented to, and "watches" the center of another object. When the parent moves, the child rotates to orient its z-axis to the watched object's new position. Both objects can move independently of one another. This link is most useful for making the camera and lights follow animated objects. Both objects can be part of other linked hierarchies.

window: The frame around and boundary of the workspace. The workspace size is determined by the size of the window. Up to ten windows can be open simultaneously in Extreme 3D and windows of different sizes are supported. The size of a final rendered image is determined by the size of the window that is selected when rendering begins.

working plane: The drawing grid that appears by default in the center of the workspace when you first open Extreme 3D. There is always one (and only one) working plane in the workspace. The working plane can be oriented to any position in the Extreme 3D world.

workspace: The portion of the Extreme 3D world that is visible in each Extreme 3D window. The workspace allows you to directly interact with the objects in the Extreme 3D world.

world: The volume of simulated 3D space in which Extreme 3D models are built and scenes are created. Every point in the world can be defined as a coordinate of the world's x-, y-, and z-axes. This virtual world can accommodate almost any size model or scene including objects scaled to actual size. It is limited only by your computer's memory capacity and speed.

world scale: That part of the world to grid scale ratio that represents the size an object is on the screen.

yaw: Rotation around the y-axis.

yon plane: *See* clipping plane.

Z-buffer render: Extreme 3D uses a z-buffer renderer for interactive renders. All 3D renderers need to solve the same problem: What happens when two pixels are in the same place, such as when one object is in front of another? Z-buffer renderers solve this problem by storing the distance of each pixel from the camera plane (the z-distance). The pixel that corresponds to the object closest to the camera is rendered last (on top).

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